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## BICYCLING IN THE AUSTRIAN ARMY.

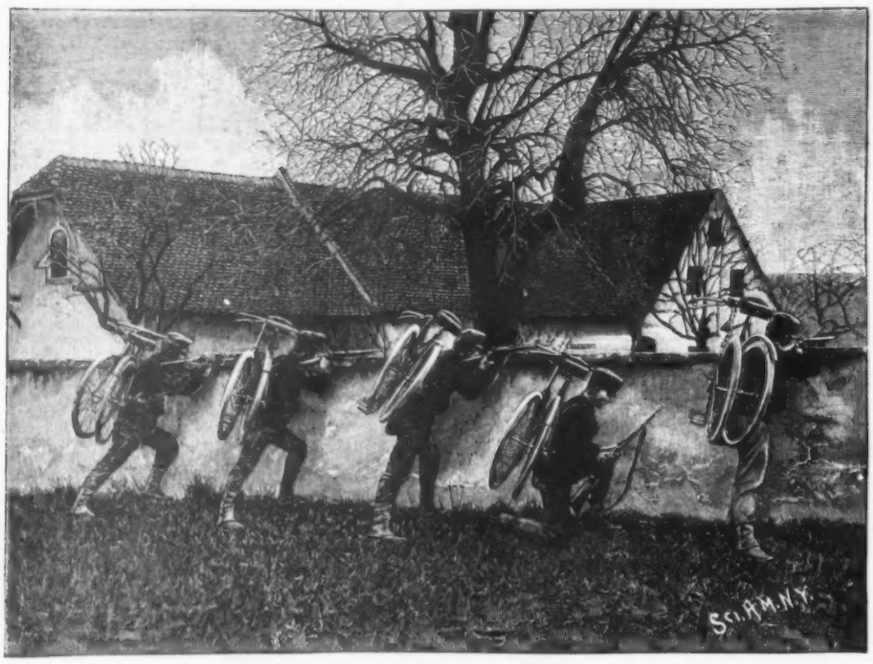
AMONG the most recent additions to military accessories we find, as we do everywhere, the bicycle. Japan, during the war with China, found in the wheel a most serviceable implement; again and again cycle-mounted detachments have been used with success in maneuvers, both for reconnoitering and for skirmishing purposes; but experience has taught that the ordinary form of bicycle is not altogether suited for military use. Woods, bad roads, and railway lines have to be crossed. Occasionally both rider and wheel have to pass over a wall. In Austria the difficulty was solved by a military man, Lieutenant Czeipek, instructor in fencing and gymnastics to the army school at Graz (Styria). He designed a bicycle which can be folded wheel to wheel in a few seconds. In this form it can readily be carried on the back. Thus is avoided the very tiring process of pushing the wheel along, if at any time riding becomes impossible. Besides, this slow progress generally resorted to hitherto is in many cases rendered impracticable by dense bushes and undergrowth, or by narrow mountain paths, where there is no room for both man and wheel. The folding cycle can be taken practically anywhere the rider is able to go. It is strapped to the shoulders in such a way that it can be carried without much discomfort over any ground for several hours. The weight of the machine is twenty-eight pounds. The gun may be strapped to the front fork. A test of this wheel has been made at the late September maneuvers at Csakathurn, in Southern Hungary, and it gave altogether favorable results.

A company of twenty-four military cyclists, under the command of the inventor of the folding wheel, was attached to the Twelfth Brigade of Infantry. They had previously been trained by a four months' course, and were sent into the maneuvers by the order of the minister of war, to test their merits.

Practical experiment showed the vast advantage of

TAKING OBSTACLES.

BICYCLING IN THE AUSTRIAN ARMY—CROSSING A BROOK.



MARKSMEN UNDER COVER.

the new wheel over the one used before, particularly on bad roads and difficult ground. While the portable cycle gave no trouble in such cases, the ordinary wheel was practically useless and untransportable. Our illustrations, reproduced from Illustrirte Zeitung, show the way in which the folding wheel is used on difficult ground, and the position it takes in the various phases of warfare. In one we see a number of men shooting from behind a sheltering wall, the wheels which have brought them to their position slung on their backs.

SKIRMISHER.

We see that this baggage in no way interferes either with the firing or with the loading.

Then we find two men riding over a railway embankment—a feat which surely does credit to the cycle and cyclist alike. Another illustration pictures a scene of progress unknown to the ordinary cyclist, and shows a party of soldiers scaling a wall with their wheels. Then, again, an instance of a skirmisher kneeling on the ground, apparently without shelter; again, he is carrying his "horse" on his back; and, again, our cyclists are crossing a brook. The scenery is most picturesque. No such crossings for the civilian cyclist!

The strategic value of the bicycle squad was clearly proved at a maneuver near Radkersburg, where they had been sent to cover the right wing of the third division of dragoons. Suddenly the detachment was attacked by one and one-half squadrons of Uhlans, but the unexpected charge of the dismounted cyclists so startled the enemy that they had to retire. On the same day the twenty-four wheelmen had another success. Taking their way right across meadows and woods, they managed to slip past the enemy's sentries and to alarm the camp at Wies by firing at the artillery from a hill close by. At the approach of hostile troops, the machines rapidly carried the riders out of range. Besides, in reconnoitering service in connection with the cavalry and infantry, in covering retreats and by the quick taking and holding of protected positions and by flank guards, the detachment did excellent work. Their sudden and unexpected appearance struck confusion into the opponent. The total distance covered by the wheelmen in the six weeks' maneuvers was 2,800 kilometers, and not once was any trouble caused by punctures or any other evil to which bicycles are subject. This in spite of the vast number of shoe nails which drop from the boots of a marching army.

The machines were all "Styria" make, constructed by the large firm, Puch & Company, Graz, Austria. These wheels, made of the best steel, have proved equally good for the racing track and the road. Their exportation to the various countries of Europe, to Egypt, Transvaal and Australia has in a short time increased so greatly that the factory, which is just now being enlarged, will, from this year onward, turn out 40,000 to 50,000 wheels annually, employing 1,200 workmen and 600 machines in their shops.

## DURABILITY OF STONE CARVING.

THE question as to the comparative desirability of executing carvings on the stone as it lies at the quarry sheds or on the stone after it has been set in place, says Mr. Fuller, in Stone, is one of considerable interest to all intelligent stoneworkers. Unfortunately, the question is not a simple one, and widely different opinions are held, according to whether the question is viewed from the standpoint of durability or from that of art or convenience. It is from the former point of view, which belongs rather to the province of geology than to that of stoneworking, that the question is here treated.

It has long been recognized that all stones, and especially the softer and more porous kinds, undergo, on exposure, a sort of hardening or "seasoning." The cause of this hardening and its relation, which is both direct and important, to the subject of stone carving, will now be considered.

The conditions which exist in the block as it is first taken from the quarry bed are first to demand attention. On investigation we notice at once that there is one property (the presence of moisture) which is possessed, without exception, by all rocks wherever quarried. The amounts of water which are absorbed, however, vary greatly and depend directly on the texture of the rock. Thus the amount absorbed by the porous sandstones is sometimes as much as 12·5 per cent. of their bulk, while the amounts absorbed by the more compact crystalline rocks, such as granite, diabase and marble, are usually only small fractions of one per cent. Even the vitreous agates are not absolutely impervious, but are sufficiently absorptive to admit of artificial coloring, and the ordinary vein quartz has been known to absorb as much as 0·08 per cent. of water.

In the following table are given the amounts of water which some of the common stones used for building are capable of absorbing.* These amounts, it should be understood, apply only to the water filling the pores of the stone, and must not be confused with the chemically combined water or that occupying cavities or fissures. It will be noticed in some cases that the amounts vary widely even in the same class of stone, indicating evidently considerable differences of texture.

The figures given are those of saturation. In nature, however, the porous rocks are saturated only when below the permanent water level, though in the case of some of the more compact and crystalline varieties the capillary attraction may be sufficiently powerful to keep the rock in a state of saturation considerably above this level, possibly even to the point where the influence of surface droughts begins to be felt. But

* These figures are based on the tables given by G. P. Merrll, in Stones for Building and Decoration.

BICYCLING IN THE AUSTRIAN ARMY—CROSSING THE RAILWAY LINES.

| | | Weight per Cubic Foot. | Per Cent. Absorbed. | Pounds Absorbed per Cubic Foot. |
|---|---|---|---|---|
| Granite... | Huron I., Mich.. | 164·4 | 0·152 | 0·250 |
| Granite... | Beaver Bay, Minn.. | 162·7 | 0·709 | 1·153 |
| Diabase.. | Duluth, Minn..... | 187·8 | 0·298 | 0·560 |
| Diabase.. | New Haven, Conn. | 162·5 | 0·430 | 0·699 |
| Limestone (Marble). | Dorset, Vt ... .. | 164·7 | 0·588 | 0·968 |
| Limestone | St. Paul, Ind.. ... | 168·1 | 0·298 | 0·501 |
| Limestone | Harrison Co., Ind.. | 149·6 | 3·703 | 5·540 |
| Dolomite.. | Stillwater, Minn... | 172·6 | 0·399 | 0·689 |
| Dolomite.. | Winona, Minn..... | 153·1 | 4·762 | 7·291 |
| Quartzite. | Pipestone, Minn... | 170·6 | 0·273 | 0·466 |
| Sandstone | Middletown, Conn.. | 148·5 | 2·500 | 3·713 |
| Sandstone | Jordan, Minn..... | 118·9 | 12·500 | 14·863 |

although rocks taken from the quarry are not, perhaps, usually saturated, they all, as previously stated, contain at least small amounts of this quarry water, as it is technically called.

Water existing in so intimate a relation to a stone as that held within its pores by capillarity, and remaining there for indefinitely long periods of time, cannot fail to dissolve more or less mineral matter, the nature of the latter being determined by the character of the stone and the source of the water. Thus rainwater is universally found to contain carbonic acid, and will act readily on limestone. Water percolating through decaying organic matter is active in the solution of certain iron salts, while water containing alkalies rapidly attacks silica.

The part played by the mineral matter held in solution by the water within the stone is as follows: When the block is removed from the quarry and exposed the quarry water begins to evaporate from the exterior, that of the interior being drawn by capillarity to the surface and likewise evaporated. As evaporation goes on the mineral matter contained in solution or suspension, as the case may be, is left as an extremely thin deposit which acts as a cement, binding together more firmly the superficial grains or crystals and forming a sort of crust.

Examples of crusts of this nature are by no means to be found only in quarried blocks. They are far from uncommon in nature, and have been described and explained by many writers. Among the most interesting of such descriptions are those given by Dr. M. E. Wadsworth.* Speaking of the St. Peter's sandstone of Mazomanie, Wis., he says that it "is composed almost wholly of a pure quartz sand, and in the outliers of it found on the hilltops south of town, the parts covered by the soil were more or less friable and the grains distinct; while the exposed portions of the same blocks and slabs were greatly indurated, the grains almost obliterated, and the rock possessed the conchoidal fracture and other characteristics of a quartzite." Even more to the point is his description of a block of Potsdam sandstone at the same locality: "the protected side of which was friable, while the other sides, especially the one most exposed to the prevailing storms, was nearly a quartzite. This block was only about two feet square, and as a test of the correctness of the above conclusion the indurated surface was broken off, and a comparatively friable surface exposed. This locality was visited the following spring (six months later), when it was found that this fresh surface was much indurated and approached toward a quartzite."

In ordinary quarried blocks, however, the action is not so manifest, for the amount of water and consequently the amount of mineral matter is seldom large. Moreover, the deposit is evidently entirely superficial, for it is only at the surface that evaporation takes place.

The importance of even a thin crust of such a character will be readily understood when the nature of the forces to which all stones used in exterior work are exposed is considered. Of these the most destructive is frost. When it is borne in mind that the pressure exerted by water in freezing at a temperature of 30 deg. F. is 276,000 lb. per square foot, it is easy to comprehend what an important part is played by frost in determining the life of a stone.

The air of cities frequently contains from 350 to 450 parts of carbonic acid to 1,000,000 parts of air, while in those cities where large amounts of soft coal are burned, sulphuric and other acids often exist in considerable quantities. These gases, being dissolved in quite appreciable amounts by rain in falling, cannot fail, when brought in contact with the component minerals of a stone by the water it absorbs, to exert upon it a very injurious influence. It is evident, then, that anything which tends, as does the crust in question, to prevent the absorption of water, must be of great value. But not only does the crust render the access of water more difficult, but by giving a less firm hold for lichens (which retard evaporation) it also renders its retention more difficult. It is, however, superfluous to say more of the effect of superficial coatings, for their value is well known and has been demonstrated in the cases of many well-known structures, of which, perhaps, the most notable is the Egyptian obelisk of Central Park, New York. Crusts formed in nature, though usually less manifest to the eye than those of artificial character, are, nevertheless, much more stable, and hence of considerably greater value.

The substances which most commonly form crusts are, in order of their value as cementing material, silica, iron oxides and lime. Their action is most important in the case of sandstone, for it is in this stone, containing, as it does, the largest amounts of water and mineral matter, that the thickest crusts are formed, and also because, most porous, it is most liable to injury by frost.

The relation which this property of stones (their ability to form crusts) bears to stone carving is evident. The crust, as already shown, is extremely thin, and if destroyed, cannot be replaced, since no further supply of quarry water is at hand to replenish that which has evaporated. If, then, durability in a carving is desired, the work should be executed at the quarry before the quarry water has had time to evaporate. The crust would then form over the carved surface, thereby increasing its power to withstand the action of the elements.

Interior carvings not being exposed to any extent to this action, are influenced but little by the time and place of the execution of the design, and even with exterior decoration the objections to carving on the placed stone would have no weight if the quarried block could be set in its proper place in a structure at once and the carving done immediately. Usually, however, months elapse between the time of quarrying and the laying of the stone, while the carving is often delayed much longer, giving ample time for the crust to form. If the carving is now executed, the protecting coating is destroyed and the prospect of the durability of the design greatly lessened.

* Proceedings Boston Society Natural History, vol. xxii, p. 302.

## FOUNTAIN IN THE COURT OF THE RATHHAUS, IN HAMBURG.

THE ornamental fountain in the court of the new Rathhaus, in Hamburg, is the work of Prof. Joseph Von Kramer, of Munich. The basin is of polished granite, while the upper receptacle is of bronze. From the center of the latter rises the figure of Hygeia, standing on a bronze pedestal that is decorated with dolphins' heads, from the mouths of which water flows. A reptile, which represents the ills that attack health, is coiled about her feet, but is kept in check by her outstretched left hand, although she is looking at the shell she holds in her right hand, and from which a stream of water flows. There are six bronze figures, comparable to the main figure, at the foot of the basin, which represent the various uses to which water is put. This fountain is not intended strictly for ornament; the falling water purifies and moistens the air which is drawn through the center and the arches in the basin, and conducted underground to ventilators in the interior of the building.—Ueber Land und Meer.

FOUNTAIN IN THE COURT OF THE RATHHAUS, IN HAMBURG.

AT the end of 1895 there were 8,243 miles of navigable inland waterways in the German empire, and a further 4,039 miles fit for floating rafts and light craft, making 0·621 mile per 2,630 persons.

## ALUMINIZED ZINC AND ITS USE IN BRASS.

So much has been said and written lately regarding the use of aluminized zinc in the galvanizing bath, and also in the manufacture of brass, that a few additional remarks on this subject will be of interest.

The reason for introducing aluminum into the galvanizing bath, and also into brass, in the form of aluminized zinc, instead of in the form of pure aluminum, is to prevent the oxidation of aluminum. In the case of aluminum brass, or in the case of aluminized zinc, the temperature at which the zinc melts is not sufficiently great to melt the aluminum. Aluminized zinc is generally made so as to contain either 5 or 10 per cent. of aluminum, in order that when a given quantity of aluminized zinc is added it may be known accurately just what proportion of aluminum is put in the mixture.

The manufacture of aluminized zinc is briefly as follows: A quantity of aluminum is taken and placed in the bottom of a plumbago crucible, and if it is desired to manufacture a 10 per cent. aluminized zinc, the proportion, of course, would be ten pounds of aluminum. After the aluminum is melted the zinc is added in small quantities at a time, being careful to keep the contents of the crucible well stirred. After all the zinc has been added to the aluminum, which in this case would be ninety pounds, the contents of the crucible is poured into moulds or cast into forms of any convenient size for breaking up. These forms generally being ingots of a certain size that weigh so many ounces apiece, so that they can add a given weight simply by counting the ingots without having to stop to weigh them; or they are cast in the form of bars of a certain size that weigh so many ounces to the running inch.

After the aluminized zinc has been manufactured, it is added to the galvanizing bath as follows: The total amount of aluminum which the galvanizing bath should contain after it is in good working order is from one-half a pound to one pound of aluminum to the ton of bath, and the aluminized zinc should not be added all at one time, but should be added gradually, in quantities of from one to two pounds at a time, depending on the size of the bath. In a five ton bath, it is advisable to add the aluminized zinc about a pound

at a time, together with the other zinc, as the bath is renewed. If too much aluminized zinc is added at one time, or, in other words, if too much aluminum gets into the bath, it will be apt to form a thick scum on top of the bath, and prevent the best results from the use of aluminum.

When aluminized zinc is used, it is not necessary to use sal ammoniac, as the effect of sal ammoniac and aluminum seems to be to counteract each other, and should too much aluminum be added to the bath, the bath can be rendered neutral, or its effect largely overcome, by sprinkling sal ammoniac on the surface and then removing this scum by scraping it from the top of the bath.

The effect of aluminum in the galvanizing bath is to make the surface of the articles appear brighter. It also allows the use of a cheaper grade of zinc in order to accomplish the same purpose as can be accomplished without the use of aluminum. Aluminized zinc also, if properly used, lessens the amount of dross. The great trouble which manufacturers find in starting the use of aluminized zinc is that they do not appreciate the great effect that a small quantity of aluminum has on the bath, and they generally use too much. It is advisable, therefore, to start with a very small quantity, gradually increasing the same until it is found just what proportions give the best results.

The use of aluminized zinc in brass has lately become very extensive, and it is used now to a greater or less extent by many brass mills that manufacture certain grades of brass. It is not advisable, however, to use aluminized zinc in a brass which has to be dipped. For some reason the presence of the aluminum prevents the acid from having the same effect on the brass that it has without its presence. For this very reason, however, the addition of aluminum to brass makes it very desirable for a large class of acid work, or where composition metal has been used. The effect of aluminum in brass seems to be to give the mixture great fluidity, and allow it to flow more freely in the mould. For brass castings and in the case of the manufacture of sheet, it gives a very strong ingot, and when the brass is rolled into sheet form it presents a good, clean and smooth surface. If a larger percentage than one-tenth of one per cent. of aluminum is added, it imparts very decidedly an additional strength to the brass, and makes it adaptable for many purposes for which the original brass is not suited. A brass which is manufactured from aluminized zinc, so that the proportion of aluminum which it contains is from 5 to 10 per cent., compares very nearly with the bronzes which are now on the market.

Aluminum brass is used extensively in places where strength is required, especially in electrical work and the electrical attachments for wires on trolley work, both overhead and underground. The use of aluminum also makes brass very tough, and you can take a brass with a few per cent. of aluminum in it and bend it into all sorts of shapes and forms without breaking it; whereas, without the aluminum it would not stand one-half the amount of work which it will with it.

The presence of silicon in brass, or in fact any of the bronzes, gives a more brittle metal, although it is harder than can be got without its use, and, of course, these two features are at the sacrifice to its ductility, which is very materially diminished, and consequently it renders the metal less malleable, and, if the metal is to be worked at all, the presence of very much silicon is a detriment. The presence of iron in either brass or bronze deducts materially from their strength, and seriously interferes with their usefulness. As a general thing, all of the brasses melt at a lower temperature than copper. Aluminum brass melts at about the same temperature as ordinary brass. The presence of aluminum in brass probably causes it to harden a little more rapidly when being worked than when aluminum is not present. This hardness, however, can be reduced by annealing the metal, that is, heating it to a red heat and then plunging it into cold water.

In regard to the manufacture of small castings, the presence of more than a pound and a half or two pounds of aluminum to the ton of brass will allow of a quarter or a third more patterns being added to the gate, which would ordinarily be used for brass castings, than without the use of aluminum, as the presence of the metal in brass gives it such additional fluidity that it will run very freely in the mould, and allow the brass to take finer impressions and give a brighter surface than will otherwise be obtained.

When it is desirable to obtain a good brass casting, or brass sheet of a superior quality, it is necessary to use good, pure copper, and likewise zinc; with the use of a small percentage of aluminum, copper of less purity and also a cheaper grade of zinc can be used, producing a strong casting, or sheet, as the case may be, at a less cost. If, however, too cheap a grade of zinc is used in castings, the presence of aluminum will cause the castings to appear dark on the surface. This is caused by the aluminum, which makes the lead, existing in the zinc in the form of an impurity, sweat out, but it is only caused when the poorest and cheapest quality of zinc is used. The aluminized zinc is added at the same time and in the same manner as ordinary zinc is added in the manufacture of brass, being careful, of course, to use it in such proportions that the resultant mixture will contain the desired amount of aluminum, which varies according to the purpose for which it is intended to use the brass. The use of very much aluminum in brass, in some cases, tends to increase the shrinkage of the castings. This can be overcome, however, to a great extent by the use of large gates and high risers.

In the manufacture of brass, as well as aluminum brass, it is advisable to use a plumbago crucible over a coke fire. If coke cannot be easily obtained, coal oil will answer satisfactorily. A coal fire, however, will not allow of a very good grade of brass being manufactured, for the reason that the gases given off by the coal will be to a certain extent absorbed by the contents of the crucible.—Aluminum World.

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It is said that rats cannot resist sunflower seeds. A trap baited with these seeds is believed to be the most effective method of catching them.

## A REIGN OF COAL AND IRON.

### IRON AND STEEL FOR ORDNANCE.

THERE is no branch of engineering or metallurgical art in which greater advances have been made than in that of the manufacture and application of iron and steel to purposes of ordnance. This is at the same time one of the most important and one of the most interesting of the many technical features of the "reign of coal and iron." In all civilized countries alike, the guns and projectiles used when the Queen came to the throne have been discarded, and we are now facing problems and conditions of a totally different character to those that were being met and regarded as the utmost attainable advances of gunnery little more than a generation ago.

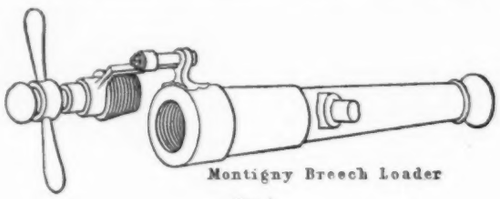
Some very interesting details as to early guns are given in a paper read some years ago by Capt. Scott, before the Royal United Service Institution, to which we are indebted for many of the facts which follow.

In the arsenal of St. Petersburg there is a gun 2¾ in. in diameter and 62 in. in length of bore, which was rifled in nine grooves in 1615. This gun is a breech-loader, and there are several wall pieces and rifled muskets in the French and other museums which were grooved about this date on plans that have been lately revived.

In 1661 the Prussians experimented at Berlin with a gun rifled in thirteen shallow grooves. In 1694 Nuremberg had a gun forged and rifled which was tested on several occasions. In 1696 the elliptical bore was known, and had been tried in various parts of Germany. In 1745, the date at which Robins was experimenting in England, the Swiss already possessed small rifled pieces. In 1746 Munich had a rifled breechloader made, and T. Senner was engaged in rifling various guns. In 1816 Reichenbach rifled a bronze gun with seven grooves. This piece is still in possession of the family in Bavaria, and has been fired with pointed leaden balls. From 1816 to 1819 M. Ponchara, a distinguished French artillery officer, was making various experiments with an old gun, which he had rifled with thirteen grooves.

In 1833 Montigny, of Brussels, invented a breech-loading rifle piece, and the Belgian government had a gun made on his plan. The arrangement of the breech apparatus was simplified in 1835.

In 1836, the late Emperor of Russia, Nicholas, sent for the inventor, and ordered breechloading guns of 18 and 24 pound calibers to be made and rifled on Montigny's plan. Eighteen hundred rounds had been previously completed in his presence from a 12 pounder. When these guns were prepared, 262 shots were fired in one day from the 18 pounder and 100 shots continuously on successive days from both the 18 and 24 pounders, and neither wad nor grease was used. But the commission, presided over by Gen. Samarakoff, rejected the plan (Fig. 1). After this Montigny, the son of the former, went to England, but his applications for an extended trial were unsuccessful.



Montigny Breech Loader

FIG. 1.

In 1845 Major Cavalli, a Sardinian officer, commenced his experiments on rifling, and these seem to have inspired Wahrendorf with a similar aim. Cavalli used a proper ring for closing the breech joint, and he also tried a copper tube in the breech of his gun, which was rifled with two grooves for a plain iron shot. (See Figs. 2 and 3.)

In 1845 the Swedish Baron Wahrendorf affixed lead to the side of elongated projectiles mechanically, and used a gun rifled with shallow flat grooves. (See Fig. 4.)

In 1847 Major Cavalli rifled an 8 in. gun, and attained good results, until the copper breech ring was blown out. The breech of the gun subsequently gave way, just as happened in his later experiments in England.

In 1851, Wahrendorf's plan of coating the shot with lead was tried at Berlin with a 12 pounder rifled in six grooves and a slow twist. The shells for this experiment were cast with two long and four short projections or studs, over which the lead coating was run. Wahrendorf also rifled guns with two grooves, on a plan similar to that of Cavalli, but the lead coating, his own peculiar plan, was preferred by the Prussians.

In Sweden, however, Wahrendorf's own country, the officers generally were opposed to the lead-coated or forced-ball system (so called from the projectile's outer surface of lead being larger than the bore, which necessitated loading at the breech), and a lieutenant in the Swedish navy, named Engstrom, affixed hard wood bearings or buttons to an iron projectile.

FIG. 3.

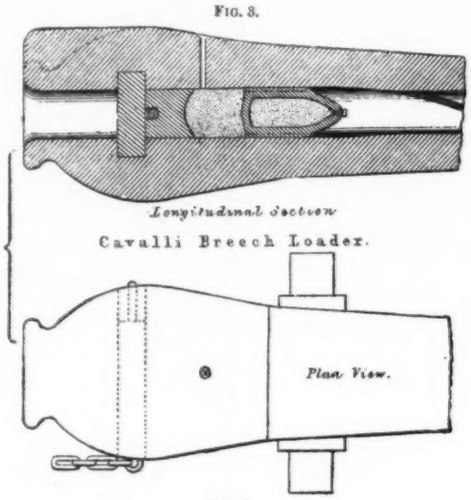
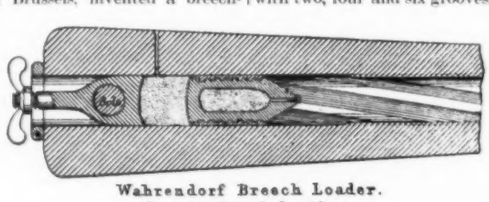



FIG. 2.

This plan was tried against Wahrendorf's lead coating system, but nothing transpired as to which had the advantage until, in the Annals of the Swedish Academy of Sciences, which were published in 1859, the preference was accorded to the Engstrom system. Both plans were afterward tested in France in 1857, by order of the Emperor Napoleon, but neither seems to have been considered a great success.

In 1856 Gen. Timmerhaus, of the Belgian artillery, invented a wad which, by taking the rifle grooves, gave rotation to elongated shot. His guns were rifled with two, four and six grooves, with one turn in 18 ft., but the results were not sufficiently good to cause an adoption of the plan.



Wahrendorf Breech Loader.
*Longitudinal Section.*

FIG. 4.

Not only plans of rifling, but also systems of breech-loading, have been continually brought forward, which have been sometimes identical with, and at others trifling modifications from those of more ancient date; and it is also a fact that nearly every modern plan of grooving was used at least 250 years ago in muskets which seem to have been fired with round leaden balls. These necessarily, gave little accuracy, and hence rifling did not supplant the smooth bore for muskets until an elongated ball was used, and it has not yet caused the smooth bore great gun to be set aside.

It should, however, be remembered that the mechan-

ical fit was unknown in the early age of rifling, and it has been reserved to Whitworth to be the pioneer in the path of shaping the shot so accurately as to center itself in a grooved gun. M. Cavalli certainly made very good practice with an iron shot, but this was from its tight fitting, which necessarily, like Wahrendorf's plan, required a breechloader; but it was not until the precision of Whitworth's guns became known that great accuracy from muzzleloaders was regarded as even possible.

The first breechloading gun upon record was used by the English in 1428, at the siege of Orleans, but whether made in England or not, is uncertain.

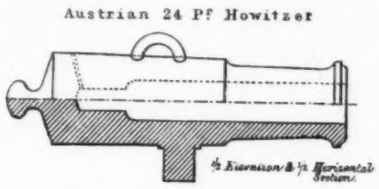



FIG. 5.

France very early made breechloaders, and her museums, as well as those of Strasburg and Bavaria, contain breechloaders of very early date, and in England there is also a large collection of foreign guns.

In 1842 Wahrendorf brought forward a breechloader consisting of a round bolt passing through and across the breech, and supporting a valve from which a handle extends to the rear of the gun. When the gun is to be loaded the bolt is withdrawn, and the valve pulled out by its stem or handle; and when this operation is completed the valve is pushed in, and the bolt shot across behind it; and they are then set tightly together by the turn of a screw upon the handle, which projects out of the rear of the gun. The effect of the discharge was to push the valve more tightly against the bolt, and the greater the force of the explosion, the more was the valve itself extended.

The gun of 1842 was designed for firing round shot, which were covered with lead, so as to close the windage. The plan was tried at Shoeburyness and on board the Excellent, but the results came far short of the inventor's expectations. Indeed, cutting off the windage entirely, from which such great results were formerly expected, is now found to be a disadvantage. Wahrendorf subsequently introduced an oblong instead of a rounded bolt for the breech apparatus of his rifled guns, and one of these was tried by the Ordnance Select Committee—the service plan of closing the breech by a screw stopper, and the later plan of effecting the same object by a pair of wedges, having proved equally unsatisfactory.

Cavalli's plan of breechloading is very similar to that of Wahrendorf, but the apparatus is less simple. There were several of his rifled guns at the siege of Gaeta, but so many accidents happened with them in the trenches that, on the bursting of a pivot gun, which reduced the gunboat to a wreck, the Sardinians, or rather the Italians, following the example of the French and Americans, abandoned the breechloader.

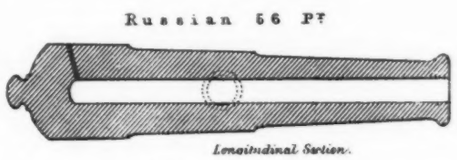



FIG. 6.

The French emperor, after satisfying himself of the superiority of Col. Treuille de Beaulieu's plan over that of Engstrom's wooden bearings and Wahrendorf's lead, at once rifled some brass pieces, and sent them for immediate service in Algeria. Here their success was apparent, but the guns were considered too heavy, and on receiving this report, the emperor rifled his light brass pieces, and thus, at a very trifling expense, France was placed in possession of the artillery which was soon to do such good service in the field. These pieces consumed their usual powder and their ordinary shot, as well as fired the elongated projectile—an arrangement that enabled the French to cut up the astounded reserves of Austria when at a distance, and to overthrow their squadrons at close quarters by the unfailing case shot.

The Austrians were taught the value of rifled pieces at Solferino and Magenta. Rifling began about 1857, and was continued through 1858 and 1859 without any decision being arrived at; but on April 4, 1860, after some previous experiments, breech and muzzle loading rifles and lead coating and French studs were tried against each other. On this occasion the emperor was present, and a unanimous decision was given in favor of Treuille de Beaulieu's plan. (See Fig. 5.)

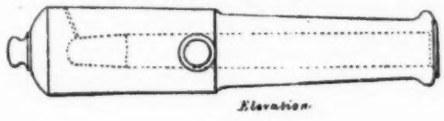



FIG. 7.

Russia began to rifle the heavy ordnance mounted on their various fortresses, on a plan similar to that of the French, about 1860. They purchased the portable rifling machines from Messrs. Vavasseur & Company, of London, with the intention of grooving the guns without moving them off their carriages; and they also arranged to use the rifling machines in a similar manner on board some of their ships; but their larger guns—120 pounders, of 10¾ in. bore firing a hollow shot of 120 lb. (the solid would be about 160 lb.), and the 56 pounders, which are like the American Columbiads—they rifle. (These earlier guns are shown in Figs. 6 and 7.)

In 1862 the Prussian army used a large number of steel field pieces made by Krupp, of Essen, weighing 800 lb. and throwing projectiles of 13 lb.; but their heavier guns were cast from charcoal iron of superior quality. With these rifled guns the Prussians retained several smooth bores, so as not to lose the advantages of the straight ricocheting and rolling of the round ball. Their early field gun is given at Fig. 8.

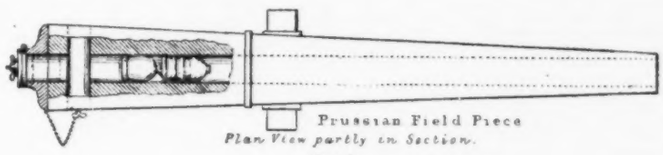



FIG. 8.

Some early guns brought out in America were known as the Dahlgren and Columbiad guns. The former was in shape very like a soda water bottle, being much rounded over the breech; the latter was rather a straighter gun; but of the large weapons, which alone seemed to be in favor in the United States, their 15 in. bore guns were the most in favor. (Fig. 9.) The gun represented was cast hollow at the Pittsburg foundry, under the direction and after the method of Capt. F. J. Rodman; it weighed 49,100 lb., and was 165 in. long in the bore; the thickness of metal through the sides of the gun at the junction of the bore with the chamber was 16½ in., and the thickness of the metal at the muzzle was 5 in.

England, about 1860, adopted a new gun, and with it a principle of rifling which could not be applied to her old artillery; she was therefore, like Prussia, obliged to retain smooth bores, and thus to have two guns to perform the work of one; and, while most other countries were reducing the various kinds of ordnance to four or six sizes of bore altogether, seven or eight small calibers and about twenty varieties of Armstrongs, in addition to as many or more different diameters and descriptions of smooth bore guns, were used here. This did not, however, lead to stopping the supply of cast iron ordnance, and we continued to make shot and also shell guns, which answered well while the round ball and the round shell were alone fired, although, even then, the larger guns were barely strong enough (from being cast of bad form and solid instead of hollow).

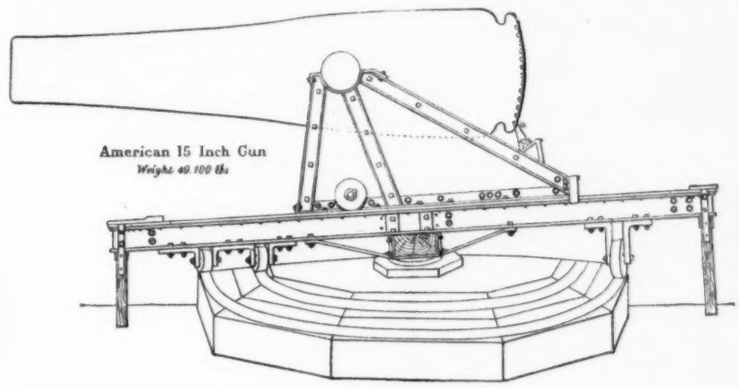



FIG. 9.

In manufacturing the new artillery difficulties soon arose, and it likewise became evident that the force required to squeeze a leaded ball through a barrel of smaller size than itself threw a strain upon the weapon which increased in a very rapid ratio as the size of the bore increased. The shunt method of rifling had been tried with a cast iron service 32 pounder in 1859, and this gun bursting at the fiftieth round indicated that upon these iron weapons; but the molten brass, after burning the iron it was thus cast upon, proved to be so yielding that the iron breech burst and opened about an inch without any apparently great strain being thrown upon the brass. Captain Blakely was then permitted to try to utilize these new iron castings, and his method stood the proof in the only gun altered by him. Subsequently, a plan of binding the breech to the rest of the gun was tested, the piece being cased in wrought iron and bound together by longitudinal bands attached to its trunnions; but the results were very disproportionate to the expense. The mistake of trying to hold on the breech longitudinally arose from the gun's breaking against the thick breech on bursting; but it is in reality first fractured at the seat of the shot, and then flies open, breaking off the pieces on each side. Another plan of strengthening was that attempted by inserting a tube of steel or wrought iron inside the larger cast iron ordnance, which were proportionately bored out; but the difficulty of getting the proper amount of tightness, the weakening of the gun where the tube abutted against the bottom of the bore and the fact that if put in without damaging the piece the tube might crack and the gun burst without warning, rendered this method unsafe. The last plan of strengthening was tried to have a greater thickness of wrought iron at the breech end, but no advantage resulted from its employment; and thus, strengthening cast iron guns was pronounced a "fallacy," and was definitely condemned. The Armstrong gun itself was, however, cited as a proof to the contrary and afforded an example of the union of two different irons (the grain of the one crossing the grain of the other), yet resulting in giving that strength which was found unattainable prior to the use of the forged breech, to which the coil tubes were welded.

In the application of steel to the manufacture of artillery, Krupp and Whitworth are entitled to rank as pioneers. Krupp gave his attention to the use of steel as far back as 1847 and produced, in 1849, a 8 pounder which, however, burst under trial. In 1855, however, the same indefatigable man sent a 12 pounder gun to England and it was found to withstand very severe tests. Between 1856 and 1862 the works of Essen produced more than 1,000 cast steel guns, the largest of which had a 9 inch bore and weighed eight tons. The use of steel was, however, hampered by numerous failures, so much so that Sir William Armstrong, in 1861, declared that he had "too hastily deferred to the general preference for steel over iron, and had since learned, by vexatious experience, the uncertainty and unfitness of that metal as now manufactured for purposes of the kind." Despite this discouragement, Krupp in the following year sent six steel guns to the exhibition of 1862, which called renewed attention to the subject, and in the following year the "Blakely" steel gun was introduced into England. Between 1858 and 1862, also, Bessemer produced 92 mild steel guns of various calibers.

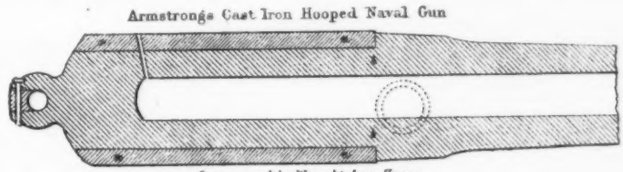



FIG. 10.

Instead, however, of hooping the existing ordnance on a plan which had proved successful, a new pattern weapon, which was thick in front of the trunnions, and very thin at the breech, was supplied. (See Fig. 10.) But as the hooping, a a, did not unite the cast iron to the wrought iron bands, the weapons had so little longitudinal strength, and were so weak at b b, where the thickness of cast iron was suddenly reduced two or three inches, that the guns proved unsafe.

The next plan tried was that of casting gun metal an increase of strength was necessary, and therefore "hooping," which had been proved a success when applied by Captain Blakely in 1856, was again resorted to.

The Russian Ordnance Department, Krupp of Essen, and the United States, have each been in front of the British War Office in the production of guns of large caliber. Russia produced in 1872, and exhibited at Vienna in 1873, a 12 in. breechloading gun, made of steel, at the Abouchoff Works, in St. Petersburg, which had a solid steel lining 18 ft. in length, forged down to 29 in.

diameter at the thickest part, and reinforced by four tires of steel rings shrunk on to the core. Krupp, in 1880, showed a 100 ton all-steel gun at the Düsseldorf Exhibition, and since then Armstrong has manufactured several 100 ton guns for the Italian and other governments. In 1888 the United States eclipsed all their previous efforts in this direction by producing—at the South Boston Iron Works—a 53 ton gun, which, however, was of cast iron, hooped and tubed with steel, the hooping consisting of twenty-seven wrought steel rings.

In the United States so recently as 1889 no steel gun had yet been constructed, and the most powerful weapons in use were converted cast iron guns with steel tubes. In that year, however, the Navy Bureau turned their attention to steel, and in 1893 the Ordnance Department took up the manufacture of steel guns on modern lines. One of the first steps taken in this matter was to procure from American manufacturers some 200 tons of tempered and annealed gun steel forgings, partly for the purpose of making experiments designed to elucidate the principles of gun construction, based on methods of treatment in manufacture, and partly to determine the strains produced by oil treatment, annealing, etc., on forgings. Even up to 1886, however, the Whitworth Company, in Manchester, supplied the largest forgings used in American steel gun construction. Since then the United States have made immense strides in steel gun construction, both in cast and in forged material.

Until a comparatively recent date, British guns were made with steel tubes only, this being the characteristic feature of both the Frazer and the Armstrong systems. This method has since given place to the production of all-steel guns, and at the present time the War Office are making experiments with wire wound guns, which are looked to by some leading artillerists as the gun of the future.

No one can gainsay the claim made on behalf of Sir Joseph Whitworth, that he did more than any one else in Great Britain up to his time to supply a material of the highest value for ordnance purposes. His view was that if highly carburized steel of great soundness were employed, it would master the gunpowder, but, in order to overcome the tendency to cracking and unsoundness in cooling, he employed a softer material than tool steel. He stood between the Scylla of soft steel, and the consequent liability to air cells, and the Charybdis of hard steel, with its liability to crack. How he overcame the difficulties of the problem in and by his system of fluid compression is well known, and it was he also who introduced the method of forging hoops and tubes hollow upon a mandrel, again by fluid compression, which is admittedly a great advance upon the old system of making steel guns from solid blocks.

The following are the specifications called for in Bessemer steel castings used in American ordnance:

| | Bessemer. | Openhearth. |
|---|---|---|
| Elastic limit | 40,000 lb. | 30,000 lb. |
| Tensile limit | 80,000 lb. | 70,000 lb. |
| Ultimate elongation | 7 per cent. | 10 per cent. |
| Reduction of area | 7 per cent. | 5 per cent. |

When the United States took up the manufacture of steel ordnance, they hesitated whether to adopt Bessemer, openhearth, or crucible metal. In their specifications, however, they assigned a much greater monetary value to the openhearth than to the Bessemer material—$5,300 against $3,300.

Thirty years ago no gun exceeding 5 tons in weight was worked on the deck of a ship, or was considered capable of being so worked. To-day guns weighing 110 tons are loaded and manipulated on shipboard, through hydraulic agencies, with the greatest ease. Muzzleloaders have been superseded by breechloaders, and power and range are ever increasing. The 80 ton muzzleloading guns of the Inflexible are considered obsolete, and are exceeded both in range and power by the newest type of breechloading 67 ton guns carried by the Trafalgar, and by later guns. The Inflexible 80 ton gun is built of iron, coiled around a steel tube, and is 27 ft. long. The newer 67 ton guns are built wholly of steel, and have a length of 36 ft., with a caliber of 13·5 in. The charge of powder used in the latter gun weighs 630 lb., and provides the projectile, which weighs 1,250 lb., with as much energy at a range of 1,000 yards as the projectile from the 80 ton gun possesses at the moment it leaves the muzzle. At a range of 1,000 yards the projectile from the 80 ton gun is capable of penetrating 25 in. of unbacked wrought iron, while the projectile from the 67 ton gun will penetrate rather more than 27 in. The projectile fired from the guns of the Benbow weighs 1,800 lb., and is capable of penetrating 35 in. of wrought iron at a range of 1,000 yards, the charge of powder used weighing 900 lb.

Many different problems are suggested for consideration by the recent advances in ordnance. One of these is obviously that of whether it is advisable to have this branch of manufacture in state or in private hands. There can be no doubt that Great Britain owes more to private firms than to government factories in respect of the improvement of the artillerist's art. Armstrong and Whitworth have done more for our armaments than ever Woolwich achieved. Our neighbors in Germany have no government factories, but depend on the private enterprise of Krupp and Gruson, and they have thereby usually been ahead of our own country. France, again, while not entirely discarding the state factories of Nevers, Ruelle, Bourges, and Gavre, has placed greater reliance of late years on Creusot, St. Chamond, and other private establishments of the first rank. Most other European nations, except Russia, buy their guns in the cheapest market, and the United States have called to the aid of the navy yard such establishments as those of the Bethlehem Iron Company, the Carnegie Steel Company, and the Midvale Steel Company.

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The oft repeated warning to surf bathers, and particularly to those who dive, to protect their ears from the water by cotton plugs, etc., is not generally heeded, to judge by the damage often traced to its neglect. They who have lost the membrane need to be especially careful, and to give up diving. The tympanum is readily protected by the cotton plugs firmly introduced, but in diving even then the air in the nasal fosse, accessory sinuses, and naso-pharynx is compressed and partially escapes by the Eustachian tubes, and in consequence the water enters so far and high in the nasal fosse as to plainfully irritate the pituitary membrane, and leads to protracted congestion.—The Laryngoscope.

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## ALUMINUM ALLOYS.

ALUMINUM and Other Metals.—With the exception of lead, antimony and mercury, aluminum unites readily with all metals, and many useful alloys of aluminum with other metals have been discovered within the last few years. The useful alloys of aluminum so far found have been largely in two groups, the one of aluminum with not more than 15 per cent. of other metals, and the other of metals containing not over 15 per cent. aluminum; in the one case, the metals imparting hardness and other useful qualities to the aluminum, and in the other the aluminum giving useful qualities to the metals with which it is alloyed.

More or less useful alloys have been made of aluminum with copper, chromium, tungsten, titanium, molybdenum, zinc, bismuth, nickel, cadmium, magnesium, manganese and tin, these alloys all being harder than pure aluminum; but it is by combination of these metals, with perhaps additions of lead and antimony, that alloys of most value have so far been discovered. Some are with additions of only 1 to 2 per cent. aluminum.

Aluminum and Tin.—Tin has been alloyed with aluminum in proportions of from 1 to 15 per cent. of tin, giving added strength and rigidity to heavy castings, as well as sharpness of outline, with a decrease in the shrinkage of the metal. The alloys of aluminum and tin are rather brittle, however, and while small proportions of tin in certain casting alloys have been advantageously used to decrease the shrinkage, on account of the comparative cost and brittleness of the tin alloys, they are not generally used. Sometimes phosphor tin is used to give additional hardness, together with good soldering properties, to aluminum alloys.

Aluminum and Nickel.—Nickel is one of the favorite hardeners used in alloying aluminum. In proportions of from 7 to 10 per cent. of nickel and the rest aluminum, the best casting metal is produced for purposes where toughness, combined with hardness and good casting qualities, is desired. "Nickel aluminum" has become a trade name. Several new nickel and aluminum alloys for jewelers and other special work have been made. Two of these are: (1) 20 parts nickel and 8 parts aluminum; (2) 40 parts nickel, 10 parts silver, 30 parts aluminum, and 20 parts tin.

Aluminum and Manganese.—Manganese is one of the best hardeners of aluminum; it can be cheaply added in aluminum casting metal by means of the rich alloys of ferromanganese, and for rolling purposes by adding the pure black oxide of manganese to the electrolytic bath in which the aluminum is produced. The alloys of manganese give special rigidity and hardness to aluminum; in combination with copper and nickel, one of the best hardening alloys of aluminum yet produced has been obtained.

Aluminum and Tungsten.—The alloys of aluminum and tungsten have for the past few years been especially popular for rolled sheets and plates, to be afterward spun. Under the trade name of "Wolfram aluminum," the metal has been largely used for military equipments. The alloys of aluminum and tungsten can be advantageously used, with the addition of copper, and also with the triple hardeners, tungsten, copper and iron; or tungsten, copper and manganese; or as usually made, the aluminum is hardened with some copper; tungstate of sodium and ferromanganese are added to the reducing bath, making an alloy of aluminum, copper, tungsten, manganese and iron.

Aluminum and Chromium.—Chromium, though rather expensive, is an especially advantageous hardener of aluminum. Aluminum hardened with chromium seems to retain its hardness, after annealing or being subjected to heat, better than almost any other of the alloys.

Aluminum and Titanium.—Titanium alloys of aluminum, although hard to manufacture uniformly homogeneous, have greater spring and resilience than most other aluminum alloys. Alloys of titanium, chromium and copper, together with aluminum, give some of the hardest and toughest light alloys yet produced.

Aluminum and Zinc.—Zinc is used as a cheap and very efficient hardener in aluminum castings, for such purposes as sewing machine frames, etc. Proportions up to 30 per cent. of zinc with aluminum are successfully used. An alloy of about 15 per cent. zinc, 2 per cent. tin, 2 per cent. copper, ½ per cent. each of manganese and iron, and 80 per cent. aluminum, has special advantages.

Aluminum and Antimony.—These metals unite with difficulty, and only in bearing metals of the class of Babbitt metals have any useful alloys as yet been discovered.

Aluminum and Lead.—These metals unite with great difficulty, and no useful alloys have yet been discovered.

Aluminum and Cobalt.—This metal also acts, with about an equal amount of copper, as a specially good alloy for hardening aluminum.

The following are two cobalt and aluminum alloys used for special purposes: Sixty parts cobalt, 10 parts aluminum, 40 parts copper. Thirty-five parts cobalt, 25 parts aluminum, 10 parts iron, 30 parts copper.

Gold and Aluminum.—Prof. W. C. Roberts-Austen has discovered a beautiful alloy, composed of 78 parts gold and 22 parts aluminum, which has a rich purple color.

Aluminum and Cadmium.—These metals have been alloyed to produce a solder for aluminum, which seems to give good results. Cadmium does not appear to act appreciably as a hardener for aluminum, as do almost all other metals.

Aluminum and Bismuth.—These two metals combine easily, the alloys being very fusible, as might be expected of alloys with bismuth. They remain unchanged in the air at ordinary temperatures, but oxidize rapidly when melted. Bismuth makes aluminum very brittle. No valuable alloys of these two metals have as yet been discovered.

Aluminum and Vanadium.—Vanadium is a good hardener of aluminum, and can readily be alloyed with it, due to its presence in some of the bauxites that are native aluminum ores.—Aluminum World.

## SELECTED FORMULÆ.

**Shampoo Paste.—**

(1.) Castile soap, white ... 4 ounces
Curd soap, powder ... 2 "
Potassium carbonate ... 1 "
Honey ... 1 "

Perfume to suit.

Make a homogeneous paste by heating with a sufficient quantity of water.

(2.) White castile soap, in shavings ... 2 ounces
Ammonia water ... 2 fl. ounces
Bay rum, or cologne water ... 1 "
Glycerine ... 1 "
Water ... 12 "

Dissolve the soap in the water, by means of heat; when nearly cold stir in the other ingredients.

(3.) Ammonia water ... 3 fl. drachms
Cologne water ... 3 "
Alcohol ... 5 "
Water ... 5 "

Whites of eggs, as many as desired.

The whites of eggs (about two) are thoroughly beaten up previous to being mixed with the water and water of ammonia; the remaining ingredients are added in their order and the whole stirred briskly.

(4.) Borax ... 2 ounces
Glycerine ... 1 fl. ounce
Rum ... 10 "
Bay rum ... 10 "
Whites of eggs ... 2

Incorporate the borax in fine powder with the glycerine and add the bay rum and rum gradually and with constant stirring to the mixture. The previously well beaten white of egg is added last, and the whole stirred thoroughly until an even mixture results.—Pharmaceutical Era.

**Gold Plating by Dipping.**—The following formula, which appears in the Zeit. Angew. Mikrosk., has been recommended: Crystallized pyrophosphate of sodium, 80 gm.; hydrocyanic acid (12 per cent.) 8 gm.; and crystallized gold chloride, 2 gm., are dissolved successively in 1 liter of distilled water, and heated to boiling. The object to be plated is well cleansed, attached to a copper wire, and immersed in the boiling fluid.

**Photographs on Watch Dials.**—For the production of photographic pictures on watch dials, the following method of procedure is recommended: Beat the white of an egg, with addition of a little ammonia, to a white foam, add 300 c. c. of water and beat again. After the egg has settled, filter and let the liquid run once over the dial, which has previously been thoroughly cleaned with ammonia. After the surplus has run off, coat once more and allow to dry.

The sensitive collodion is now produced as follows: Dissolve 0·6 gm. chloride of zinc in 20 c. c. of alcohol, add 0·5 gm. collodion cotton and 26 c. c. of ether, and shake the whole forcibly. Then dissolve 1·5 gm. of nitrate of silver in hot water, add 6 c. c. of alcohol and keep the whole in solution by heating. The silver solution is now added in small quantities at a time to the collodion, which must have well settled. This, of course, is done in the dark room.

After twenty-fours the emulsion is filtered by passing it through cotton moistened with alcohol. This durable collodion emulsion is now flowed in the usual way thinly upon the prepared watch dial, which, after the collodion has coagulated, is moved up and down in distilled water until the fatty stripes have disappeared. The water is then changed once, and the dial is, after a short immersion, left to dry upon blotting paper. It is now ready for exposure. Expose under the original magnesium light and develop with a citrate oxalate developer or in the following hydroquinone developer:

Hydroquinone ... 4 gm.
Bromide of potassium ... 25 "
Sulphite of soda ... 48 "
Soda ... 10 "
Water ... 450 c. c.

After fixing and drying, coat with a transparent positive varnish.

In place of the developing process, the printing out process with chloride of silver collodion can also be applied, with the advantage that the pictures can be toned. The collodion for this purpose is made in the following way:

Dissolve 8 gm. collodion cotton in 100 c. c. of ether and 100 c. c. of alcohol, add 0·3 gm. chloride of strontium, and then 0·2 gm. chloride of lithium, which has previously been dissolved in 2 c. c. of hot water. To this solution add also 1 gm. citric acid which has been dissolved in alcohol slightly heated. The solution is left standing for twenty-four hours and is then filtered through cotton. The prepared dial is coated in the ordinary way with this emulsion, and printed, after which it is toned as usual.—American Druggist.

**Hair Curling Powder.—**

Tragacanth powder ... 4 ounces
Borax ... 1 drachm
Soap bark powder ... 40 grammes
Oil rose geranium ... 1 drachm
Oil rose ... 6 guttæ
Oil cinnamon ... 8 "
Oil bitter almond ... 4 "
Extract musk ... enough

About a drachm of the powder to eight ounces of water will produce a satisfactory preparation.

**Woodhouse Indelible Ink.—**

Silver nitrate ... 1 ounce
Infusion nutgalls ... 2 drachms
Acacia ... 2 "
Water ... 8 ounces

Dissolve the nitrate of silver in 4 ounces of water. In the remainder of the water dissolve the acacia and add the infusion. Then mix the two liquids. The infusion of nutgalls is made by pouring 1 ounce of boiling water upon 30 grains of powdered nutgalls.

## ENGINEERING NOTES.

**Foreclosure sales** of American railroad properties were effected last year to the nominal value of $1,150,000,000 stocks and bonds. In other words, the nominal value of the securities issued by the foreclosed lines sold last year was $1,150,000,000. The corresponding aggregate for 1895 was $761,000,000; and for 1894, $319,000,000.

**A great** reservoir which is about to be built in the Nashua River basin to supply Boston and its suburbs with water will entail the practical obliteration of West Boylston, which lies in the middle of the area proposed to be used for reservoir purposes. West Boylston is a factory town, giving employment to several hundreds of operatives in various cotton mills.

**The casting** of the largest manganese hub ever made in the United States for a ship's propeller wheel was recently successfully accomplished at the foundry of Caskey Brothers, the Newport News Iron and Brass Works. This hub is the sixth and last which this firm contracted to furnish for the three battleships now being built by the Newport News Shipbuilding and Dry Dock Company, and required over 14,000 lb. of metal to be poured. When finished, the hub will weigh about 9,600 lb. The work of preparing and pouring the casting was in all respects most successful, and the next casting of importance at the works will be one of six large, high pressure cylinders for the engines of the battleships. This firm is also filling an order for 36 large manganese propeller blades, which weigh 6,000 lb. each, for the battleships, and have quite a number of orders on hand for other manganese blades, so that they are very busy.

**The torpedo** boat Porter went on dry dock in the navy yard with her steel bottom entirely bare of anti-fouling paint and with little left of the protective coat which had been put on less than a month ago. Two weeks ago Lieutenant Fremont, in command of the Porter, and other officers of the boat, in the clear water off Newport, observed that the vessel's bottom was becoming bare of paint. On arrival here she was put in dock, and it was found that the last coating, applied less than a month ago to prevent fouling, had been entirely swept away. This is said to have been caused by the rapid speed of the boat through the water. This is the first instance ever recorded in which the bottom of any sea-going vessel has been stripped of its paint by the friction of the water caused by a high rate of speed. The Porter has been repainted, and will come out of the dock with protective coverings on her hull which it is hoped by her officers will prove more stable against the wear of the intense speed maintained by this remarkable boat in action.

**The Roumanian** government is justly proud of the magnificent railroad bridge, now completed, over the Danube River at Czernavoda, which for more than nine miles crosses the Danube proper and the so-called inundation which is annually under water for a certain period of time. The largest spans are over the main current of the river, there being one of 620 feet and four of 455 feet each. The total length of the bridge proper, without any approaches, is 13,325 feet, while the largest railroad bridges in the world, in other countries, are the Tay Bridge, Scotland, 10,735 feet; Mississippi Bridge, at Memphis, 10,600 feet; the Forth Bridge, Scotland, 7,800 feet; the Morody Bridge, in Galacia, 4,800 feet; and the bridge over the Volga, near Sysran, 4,700 feet. The clear height of the bridge over the main channel is so calculated that even at high water the largest vessels sailing on the Danube may pass under it, and the clear height of the distance from high water mark, which is taken at thirty-five feet above low water mark, measures 105 feet to the lowest rafters of the superstructure.

**Along the** river front at Liverpool, says Cassier's Magazine, there is a tendency for the accumulation of silt against the dock walls, requiring occasional dredging for its removal. Instead of using scoop dredges, this mud is removed at different periods by the use of tide power in the following manner: Along the base of the dock walls is laid a pipe, perforated with holes, directed outward, this pipe being connected with the interior of the dock system, and suitable valves being provided to permit or check the flow of water. When the tide is very low, and consequently the head of water measured from the surface in the docks is at its greatest, a sudden opening of the connection permits a rapid flushing action by the water escaping through holes in the pipe at the base of the walls, scouring out the mud and driving it out into the river to be carried away. Ultimately, no doubt, the introduction of practical and economical forms of power storage will render the equalization of tide power commercially practicable, but at the present time this example serves to demonstrate the fact that solar and lunar attractions have been harnessed in a small way at least.

**In a** recent report to Lord Salisbury by the English consul at Barcelona are "some hints which may well be considered by American manufacturers who would like to have a South American market for machinery. The consul says that in the way of catalogues much remains to be done by the majority of manufacturers. They ought to bear in mind that it is almost useless sending out catalogues in English. More care ought to be observed in the translations, which are often evidently confided to persons entirely ignorant of machinery, with the result that Anglo-Spanish catalogues are often as funny as Germano-English. It is absolutely necessary for the proper translation of machinery catalogues that the translator should understand not only the language, but also the machinery. Again, some otherwise valuable catalogues are spoilt by the weights and dimensions being given in English instead of being reduced to the metric system, while production is stated per day or week without specifying the hours, and consumption of gas or petroleum motors is given in pence per horse power, instead of in cubic meters of gas or liters of petroleum. The catalogue which stands the best chance of being kept and consulted is the small or medium sized pamphlet or book, in which prices, packing and delivery charges, f. o. b. to shipping port, gross and net weights and cubic measurements are all clearly stated. Copies of testimonials are useless, a well digested list of users being of more value to convince the purchaser."

## ELECTRICAL NOTES.

**There is** said to be a telegraph and telephone line between Chicago and Milwaukee that is a mutual concern. The patrons own the line and pay five cents a message. The line has paid for itself and the cost of operation, and returns a dividend annually. The dividends are applied to the extension and improvement of the service.

**It is** said that there is likely to be considerable development of electric railways in Russia. There is a road already established at Kief, and one at Nijni-Novgorod. These were built by Germans, but are operated by Russian companies. A Finnish company acquired a charter for building an electric railroad in Sebastopol, and also for electric lighting; but this has been turned over to a Belgian company, which is negotiating for rights to build electric roads in at least four other places.

**According to** L'Electrochimie, in the Swan process a very thin, polished sheet of copper is immersed in an appropriate gold solution and the electric current passed long enough to give a continuous coating. The plated copper is then taken out, washed and immersed in a solution of ferric chloride, by which the copper is dissolved and leaves the gold intact in the form of a leaf not over 0·0001 millimeter in thickness. It is impossible to measure such a thickness, and it is ascertained approximately by weight.

**The Kansas** City Board of Education has made a contract with the Missouri and Kansas Telephone Company for telephone service in all the public schools, says the Electrical Engineer. A switchboard will be placed in the secretary's office and private lines run to all the school buildings. This service was decided upon by the board for sake of convenience and for use in case of fire in any of the school buildings, or to give the alarm to the teachers if a heavy storm be approaching. The city has had some lively experiences with cyclones, and parents like to get their children home out of the way.

**An emergency** case of long distance electric transmission took place between Canton and Massillon, O., on May 19, says the Engineering News. The two cities are about eight miles apart and their street railway systems are owned by the same company. The chimney of the plant at Canton was being repaired and during the day it was out of use the Canton railway was operated by current generated in Massillon. The two lines had been built at random, and for a distance of six miles the current (520 volts) traversed a single No. 000 wire. The extreme distance to which the current was carried was about 11½ miles. The number of cars in Canton was reduced to about one-third of the usual number. The arrangement worked all right, except when a heavy interurban car was ascending a hill between the cities, when it would consume all the power and the cars in Canton would almost stop.

**There are** in all thirty-two miles of tramway lines in Hanover on which electric traction is used, and seventeen miles on which horse traction is still retained, says The Engineer. There are 29 motor cars for the trolley lines and 63 which can be used either on the trolley or accumulator lines. In addition, 110 accumulator cars are being built, and before the end of the summer the accumulator system is to replace the overhead system on all lines. The generating costs averaged 0·66d. per kilowatt-hour during the first half year of 1896 and 0·59d. during the second half year, being during November and December only 0·54d. This improvement is attributed to the increased use of accumulators. The entire working costs amounted to 68·2 per cent. of the year's receipts, as compared with 75·8 per cent. last year. £14,170 has been set aside for depreciation, and a further sum of £400 for extra expenses in connection with the accumulators.

**The New York** Electrical Review describes the electric lighting and signaling on the Cincinnati and Southern Railway. Track circuits are largely used, and the signals are automatic—i. e., the train leaving the section lowers the signal without the intervention of the signalman. Grade crossing bells are used to warn persons crossing the line of approach of a train. The Cincinnati and Southern has a bad crossing with another line at Nicholasville in Kentucky. This is electrically interlocked. On the Cincinnati and Southern the locomotives of the fast passenger trains are equipped with electric headlights, which have been found to be extremely practical and advantageous in service, and which are well liked by the enginemen. "The general outside appearance of the electric headlights is very similar to the ordinary standard oil light. Current is furnished by a combined engine and dynamo set of 4 horse power capacity, located behind either the headlight or the steam dome, or else under the running board of the locomotive. The are light is of 2,000 candle power. The electric headlight is controlled from the cab of the locomotive. All that is necessary to start the light burning is to turn the steam valve so as to start the engine."

**Aluminum is** beginning to be used quite extensively for electrical purposes, says the Aluminum World, and there is now strung in the stock yards of Chicago a half mile of aluminum telephone wire. The wire was put up six weeks ago, and when recently inspected was found to be in good working order. Though it was strung under the most unfavorable conditions, being subject to blasts of soot, steam, etc., it seems to withstand wear remarkably well. There is one span of 400 feet, and it is apparently as taut as when first put up, and shows no evidence of stretching. If, after a thorough trial, aluminum gives entire satisfaction, it will probably be strung in many places for telephone service. The electrical conductivity of aluminum was recently thoroughly determined by Profs. Joseph W. Richards and John A. Thompson, and published in pamphlet form. Annealed wire has a conductivity very nearly one per cent. greater than the unannealed. The conclusions drawn from their experiments were that the conductivity of hard drawn commercial aluminum is strongly affected by impurities, and that by marking the conductivity of copper as 100, the different grades of aluminum compare approximately as follows: 98·5 per cent. pure, 55; 99 per cent. pure, 59; 99·5 per cent. pure, 61; and 99·75 per cent. pure, 63. It was estimated that 100 per cent. pure aluminum would have a conductivity of 66, as compared with copper rated at 100.

## MISCELLANEOUS NOTES.

**The Imperial** Technical Society, of St. Petersburg, has appointed a committee under the presidency of Prof. Schuljatschenko to report on higher technical education. It appears that in the Russian works (excluding Siberia and the Caucasus) 4·97 per cent. of the managers are technically educated Russian subjects, and 2·14 per cent. foreigners. On the other hand, 88·13 per cent. of the managers who have received no technical education are Russians and 4·76 per cent. foreigners. It follows that in Russia only 7 per cent. of the works are directed by managers who have received a scientific education.

**"The average** man, I presume, imagines that garnets are used in our line of business exclusively," remarked a Chicago jeweler, the other day, "whereas, in fact, the jewelry trade cuts a small figure in the garnet industry. About 3,000 tons of garnets are used every year in this country for making sandpaper. A very small proportion of the garnets have any value to the lapidary, and the best are only semi-precious stones. The costliest come from the Adirondack regions and from Delaware County, Penn. Up in Alaska, near the town of Wrangel, is a veritable garnet mountain, and a corporation has recently been organized to develop it. The Alaska garnets are said to be unusually fine."

**Woven paper** is a new article invented by W. A. Maurain, a Providence, R. I., manufacturer, which is designed as an improved kind of lining for carpets. A novel description of loom is employed in its production, and into this loom strips of the paper a yard long are fed automatically through a tubular guide, which folds them lengthwise; these strips form a firm yet elastic weft a quarter of an inch thick and securely bound by warp threads. From the loom the woven roll is taken to a machine which gums and stitches on the paper selvage and reinforcing strips of paper. In another grade the lining, as it comes from the loom, is inclosed in paper, which, when worn away by use, leaves the interior intact. The filling does not adhere to the carpet. Its thickness gives an elastic feeling to the carpet, and the loom insures a uniform product.

**A government** report from Colombia contains a description of a tree, known as the chaparro, which is said to possess the quality of being fireproof. It grows on the vast plains of Colombia and the north of South America, called savannas, extensive districts which are parched with heat except during the rainy season. It has long been the custom to clear the ground for the new vegetation which springs up so luxuriantly on these plains after the rainy season by means of fire—and such fires, miles in extent, kindled by the herdsmen, destroy everything in the shape of vegetation, except the chaparro tree, which survives to afford a welcome shade in an almost treeless region. It is a small tree, seldom growing to more than twenty feet in height, with a girth of about three feet, and it owes its protection from fire to the nature of its hard, thick bark.

**A flume** 35¾ miles long has been constructed to carry water from the mountains into the city of San Diego, Cal. The flume is of redwood, and required 9,000,000 feet to build it. From 75 to 125 men, besides teamsters, were employed in the work. In the course of the flume there are 315 trestles, the longest of which is 1,700 feet, and 85 feet in height. The building of this trestle required 250,000 feet of timber. The Sweetwater trestle is 1,200 feet long and 85 feet high. The main timbers used in this trestle are 10 by 10 inches in size. There are eight tunnels in the course of the flume, the longest of which is 2,100 feet. The tunnels are 6 by 6 feet in diameter, with a convex shaped roof. Much of the lumber for construction had to be hauled 700 to 800 feet up the rocky sides of mountains. The lumber was loaded on cars that ran on a portable track, and the cars were pulled by a heavy wire cable.—Northwestern Lumberman.

**The largest** postage stamps ever issued measured four inches by two—the size of the old United States five cent stamp, restricted to packages of newspapers and periodicals posted in bulk and never intended for letters. The penny Madagascar stamp, second in regard to size, three inches by one and one-half inches, was used to prepay postage on letters posted at the British consulate at Antananarivo, where there was no other post office in 1886. The private postage stamp of Robinson & Company's express, with its figure of a bear, is two and three-quarters by one and one-half inches. The stamp entitled "California penny postage from the post office, care of Penny Post Company," for 1885, is in size two and one-half by one and one-quarter inches. The quarter shilling stamp of Mecklenburg-Schwerin, which was issued in 1856, is the smallest ever issued—less than one-fourth the size of the current penny English stamp—and it would take about fifty of them to cover the surface of the largest issued by the United States.

**The London** Financial News says: "It is rather curious to notice that the Belgian International Exhibition, which is now open, was devised at first as a speculative company scheme, and met with only scant support in the beginning. The limited liability feature has not yet disappeared; but the enterprise assumed a more reassuring aspect when King Leopold and the Belgian government officially countenanced it and put it on an international footing. Every European nation, with Japan, Persia, Siam, all the South American republics and Mexico, made liberal appropriations for their respective exhibits; but, strange to say, the United States went no further than to vote a pittance of $5,000 for a preliminary commission; so that the great business interests of the country have had to look out for themselves. It was plainly a mistake. The republic has now only 7·9 per cent. of Belgium's total trade, against France's 17·8 per cent., England's 11·5 per cent., and Holland's 10·4 per cent.; while it should naturally have a large proportion of the leading imports—grain, raw textiles, building woods and furniture. Belgium competes with our own trade in so many lines as a manufacturer that the pecuniary advantage to be gained by an appropriation of £50,000 for our representation may be questioned. Still, France and Germany, who laid out an equal sum, are in the same category of rivalry, and if we were to be represented at all, it was necessary not to be behind them in our outlay."

## THE FESTIVAL AT RUNKELSTEIN CASTLE, NEAR BOZEN, TYROL.

A SOCIETY has been formed under the name of "The Runkelsteiner," which consists of Bozener lovers of art and nature, and which has for its object the keeping up of old traditions and customs by giving historical festivals. A feast of such nature was lately given at the castle, the idea on which it was conducted being somewhat as follows: In 1417 Francis der Vintler, squire of Bozen, who lived at the Runkelstein Castle, invites the Wolkensteiner Oswald, a celebrated singer and knight, with his young spouse, Margarete of Schwangau, to be his guests at the castle. Both are on their honeymoon to the south, and with them appear before the Vintler the afterward so much feared Knights of the Elephant Order.

In honor of these guests great festivities are held at the castle, lasting many days, and sending far the fame of the Vintler's hospitality.

This is the plan on which the feast is once more conducted in our present days. Invitations worded in quaint old language are sent far and wide, and thousands accept the invitation. Bozen and its surroundings have never before seen such an aggregation of strangers, and soon every sheltering place is filled.

A preliminary feast on the greensward at Gries opened the festivities. This, too, was held on historical lines. "A dazzling procession of costumed men and women, all in strictly historical order, filed through the streets of the town along the dense crowds on either side. Arrived at the place where the feast is to take place, a series of horseback and other games were instituted, and till late at night the gayeties were continued. The presence of the Grand Dukes Francis Ferdinand and Ferdinand Charles, and the patroness of the committee, Princess Mary Raineria of Campofranco, gave the festival a special attraction.

One of the attractive features was the salute of the procession before the princely couple of Campofranco. The armored knights and retainers lowered their lances and swords, the matrons and young girls in the four brilliantly decorated carriages waved their kerchiefs, and the heralds blew their trumpets, while all eyes were fixed on the princess, who, with her husband, reviewed the procession from the balcony.

More brilliant still were the festivities at Runkelstein Castle on the next day. This stronghold was presented to the inhabitants of Bozen by the Emperor Francis Joseph in 1893.

Where the rolling waters of the Talfer break forth from the Sarne glen, swiftly streaming to the wide valley of Bozen, there on a high rock rises Runkelstein Castle. No stranger on a visit to the town returns home without seeing the castle, which is famous in the circles of art lovers for its interesting frescoes. Half an hour's walk from Bozen will take you to the castle's doors, and well rewarded for his trouble is he who has come to look from the top of the walls over the wonderful scenery on all sides.

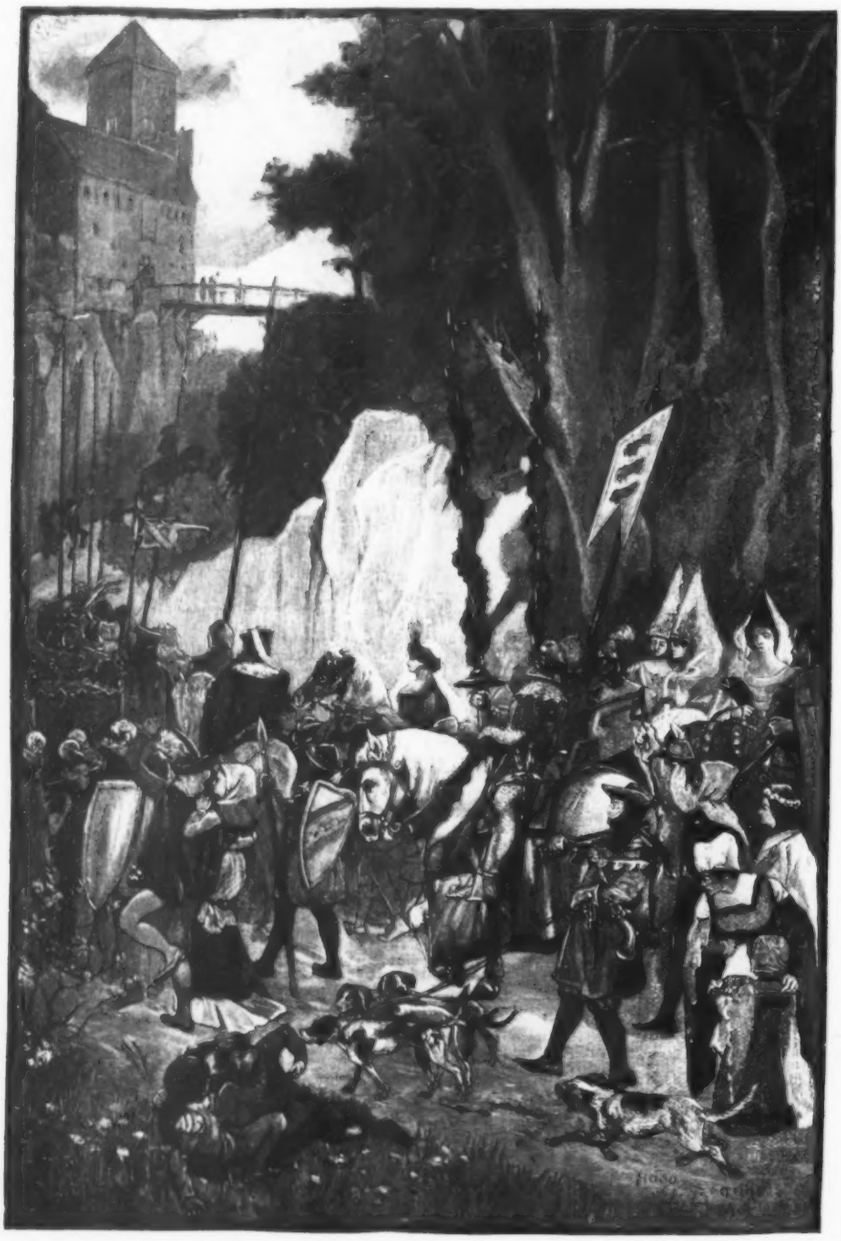
At noon already strangers and Bozeners began to move toward Runkelstein, either to take an active part in the festivities at the castle or to take their stand at the foot and to watch the richly costumed procession ascend. Now they come, slowly filing up from below, the single troops arranged according to the castles of the different noble families, with them the patricians and citizens led by the mayor, here and there a nobleman with his hunting suite, pages bearing their ladies' trains, gay groups of children dressed in brilliant colors, then again noble ladies in graceful attire, knights resplendent in their glistening armor, on fiery steeds, then the wandering minstrel, quick falconers, and merry players with their lutes.

Our illustration, for which we are indebted to Illustrirte Zeitung, represents the moment when the Knights of the Elephant Order are escorting Oswald von Wolkenstein to the castle. The lord of the castle, Francis der Vintler, gives the entering guests the salute of welcome, after the herald of the castle has called together the various groups by the sound of his trumpet.

From the galleries of the castle fine ladies were watching these ceremonies, among them the Princess of Campofranco. Out of the many items of the excellent programme a feature specially worth mentioning is the competition for the laurel wreath by the singers. It is won by Walther von der Vogelweide, and the lady of the castle places it upon his head, under the loud applause of the spectators.

When night cast its shadows over Runkelstein the pinnacles of the castle were lit up by flaming bonfires, which threw their rays upon a scene of unmixed merriment and clothed the wave of the Talfer below in fiery splendor.

At a late hour the costumed figures left the castle, and with the strains of gay music returned to Bozen, which, by the unanimous judgment of all its guests, may rightly be proud of this festival.



PROCESSION IN MEDIÆVAL COSTUME ON THE WAY TO RUNKELSTEIN CASTLE, NEAR BOZEN.

## FIRE BRICK COLORATIONS AND THEIR SIGNIFICANCE.

By CHARLES FERRY.

IT will be interesting, no doubt, to the consumers of fire brick to study the nature of the substances that give refractory brick their color, to learn, if possible, how these effects are brought about and what they mean to the fire brick manufacturer. In an inspection of various specimens of fire brick we see the three general surface colors, white, brown and red, with all the intermediate shades and arrangements of them, hardly two quite alike.

Fire Brick with White Surfaces.—Whenever a pure fire clay (silicate of alumina), containing practically no accidental impurities, is burned in a kiln with an oxidizing flame, the calcined mass has a white color. An oxidizing flame is, as the term implies, one which contains more than enough oxygen to satisfy the carbon in it. In other words, ignition of the carbonaceous matter is complete when it has all been converted into carbon dioxide with no free carbon escaping in the form of black smoke. The composition of a green fire brick before it is set in the kiln may be as free from the accidental impurities as the mass of clay just referred to, and if burned with a clean, sharp, oxidizing flame comes from the kiln as white as snow.

Because of the lack of color, can it be said that this brick has not been thoroughly ignited in the kiln and its constituents completely bound together? No. To produce a sound, tough fire brick, 1, it must receive its kiln treatment continuously from "start to finish" without giving the temperature a chance to recede until the ware has received the proper amount of heat; 2, it is very necessary that the temperature should reach such a point that the essential bond can be formed throughout the brick's molecular structure, whether it be a "kaolinite" or a "fusion" bond. To produce the maximum number of heat units from a given weight of coal we must have the entire oxidation of the carbon in the fuel during the process of ignition. To avoid making soft, friable brick the heat of the kiln has to be raised to the required intensity. It is easy to see then how fire brick may be adequately baked by a clean, oxidizing flame and converted into a mass almost colorless, though equally as tough and sound as another fire brick of the same grain and composition burned in a kiln with a smoky reducing flame. As a matter of fact, the light colored fire brick are more apt to be thoroughly baked than those highly colored, if this coloration only exists on the surfaces and has been imparted by the carbonaceous (black) reducing flame, for the soundest fire brick are produced in the hottest kilns, and such temperatures can only be effected when the fuel has had enough air (oxygen) to convert its carbon into that colorless gas, carbon dioxide.

I think there are many consumers of refractories who have a theory that no fire brick possesses its best physical condition unless it bears a brownish stain, purely organic in nature and not derived from the original composition of its mixture. When we consider that excessive heat is the only means by which the effective bond is imparted to the fire brick mass, and also that the surest method of raising the kiln to the desired temperature is by introducing plenty of oxygen, or just what destroys the flame's ability to impart this stain, it is easy to see that the brick's lacking in surface color is absolutely no proof that its constituents are not thoroughly cemented together.

Brown Surface Stain.—While it is true that the light colored fire brick are as often well baked as those carrying a brownish stain, it is interesting to observe how the theory first became recognized that only the fire brick having a well defined surface stain were properly burned.

The old method of burning fire brick, that still remains a good one though not quite as cheap as some of the modern schemes, is to set them in an up-draught kiln into which the fire enters directly from the fire holes distributed around the bottom of the kiln and passes up through the green brick and finally out of the chimney in the top. A down-draught kiln, though not modern in itself, has not been applied to the manufacture of fire brick in this country on a large scale until recent years. The green brick receives the flame from the top in this type of kiln, and the hot gases pass down through the brick work and out by means of flues in the bottom. This method gives the hot fuel carbonaceous gases a better opportunity to unite with the oxygen from the air before they reach the green brick in the body of the kiln, because after leaving each fire hole they have to pass upward through a flue into the top, or "crown," of the kiln, then down and distribute themselves throughout the brick checker work.

When the flame reaches the interior of the kiln in either method its chemical nature will be reducing (excess of carbon) or oxidizing (free from carbon and with an excess or surplus of oxygen), according to the volume of air admitted through the fire holes. If the fire goes directly from the fire hole into the bottom of the kiln and then upward, it is apparent that the wares that fill the lower section of the kiln are more liable to receive the smoky reducing flame rather than the effect of a clean heat produced by a perfect combustion of the fuel gases.

Now let us consider the nature of the component parts of a green fire brick. We have in it the calcined clay or anhydrous substance, whichever it may be, though both of a very low shrinkage factor, and mingled with

it the required proportion of raw plastic fire clay. This constitutes, in general terms, a fire brick mixture. In burning a kiln of green fire brick, during a short period at the start the fires are kept low and the wares are relieved of their hydroscopic water. On account of the strong tendency of the plastic clay to hold back even its uncombined water, it is not probable that all of the moisture is expelled by such a slow fire. When the green brick have been thoroughly dried out or "water smoked," the doors of the fire holes are closed and the temperature of the kiln is raised very gradually until the bricks have assumed a cherry red color. If a brick were taken from the kiln just at this point and examined, it would be found to be extremely porous and friable. Its porosity is the result of a loss of hydroscopic and combined water.

Now it is easy to explain why such a fire brick is less able to retain a brown organic stain than the wares that are more effectively baked—viz., to a point when the interior of the kiln has taken on a white heat. If the exact dimensions of a soft, friable fire brick, baked at a red heat, were taken and then this same brick properly fired at a white heat, the diminution of its length would represent a shrinkage factor. In other words, the particles in the hard porous fire brick have been softened to an extremely limited extent at the very intense white heat, and as a result they have become more solidified, closing up a large percentage of small interstices left behind after the moisture and water had been driven off.

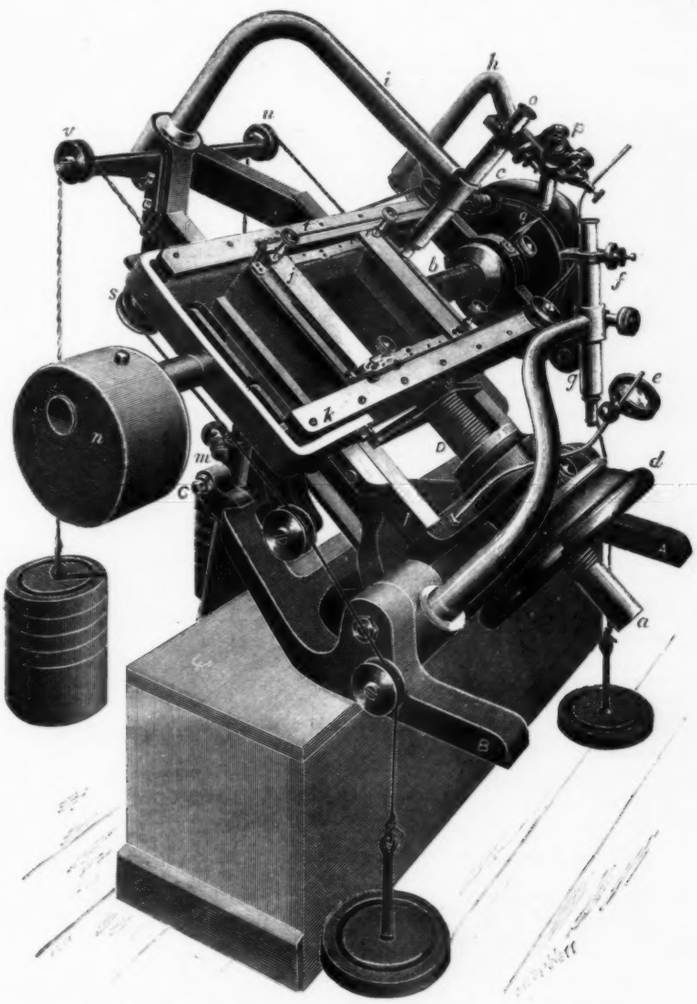
Now if the kiln fireman continues to make his flame reducing, or keeps it charged with fine carbon while the kiln is white hot inside, many of these infinitesimally small particles of fuel will naturally enter the surface pores of the brick, and as the mass shrinks they will be retained there. This is a thoroughly practical explanation of what happens when a fire brick absorbs the brown surface stain. It is of really no significance or value to the consumer. To condemn fire brick that have no organic surface coloration is unfair and unreasonable. A fire brick can be burned just as hard and sound in an oxidizing flame where it will be only slightly discolored as in that smoky reducing flame that only imparts a peculiar surface color to the ware and makes it appeal to the fancy of those who are used to buying highly colored fire brick.

The Reddish Coloration.—The pure organic stain lies between a straw color and a light brown. A reddish tinge is usually characteristic of those fire brick carrying a perceptible amount of iron. The consumer who buys the hard burned light colored fire brick always has a great deal of satisfaction in the assurance that it is practically impossible to burn fire clay containing an appreciable quantity of iron in an oxidizing flame without imparting to its surface that well-known reddish color of ferric oxide. If the organic surface stain is given to a fire brick carrying some iron, the condition of the flame in the kiln is such that it reduces the iron to a state where its own color is almost obliterated and replaced by a fuel stain which is somewhat deeper in color than that found on the fire brick having no iron in it. For such fire brick it is advantageous to the manufacturer that the fuel stain should be strictly adhered to, though sometimes its presence is misleading to the purchaser.—The Iron Age.

## APPARATUS FOR MEASURING STELLAR PHOTOGRAPHS.

THIS instrument, which was designed by Professor Kapteyn, of Groningen, has been employed for carrying out the system of measuring the star positions by rectangular co-ordinates. This instrument is one in use at the Harvard College Observatory, Cambridge, U. S. A. It consists, as will be seen, of a base casting, A B C D, to which is hinged the frame carrying the guides and movable table on which the plate to be measured is mounted. By means of the bar and clamping screw, m, the frame and table may be adjusted to any inclination which may be found convenient in use. An angle of about 40° is found suitable in practice.

The photographic plate to be measured is mounted on the frame, j, which is provided with four screws for adjusting the plate to the focus of the observing microscope, o. The frame, j, slides horizontally in the guides, t, k, its movement being effected by the screw, b, which carries a mahogany hand wheel, c, and a divided index wheel, q. The circumference of this wheel is divided into 1,000 equal parts, and a pointer, q, and reading microscope, p, are provided as shown. The weight of the screw and handwheel, etc., is counterbalanced by the adjustable weight, n.




APPARATUS FOR MEASURING STELLAR PHOTOGRAPHS.

The guides, t, k, are attached to a frame which moves on the guides, l, thus giving motion to the plate in a direction at right angles to that given by the screw, b. The motion on the guides, l, is given by the screw, a, which is 1¼ inch in diameter, and is cut with a thread having a pitch of one-fifth inch. This screw is provided with the mahogany handwheel, d, and the index wheel, y, the latter being divided on its periphery to 1,000 equal parts. These graduations are read by the microscope and micrometer, f, g, while an eye lens, e, having a low power and a very broad field, is provided for reading by estimation.

The screws moving the plate holder were cut by the process devised by Professor Rogers, this process providing for the correction of periodic errors in a single revolution of a screw independently of changes in the pitch. Errors of the latter class are removed by means of a template which has the curvature required to move the carriage of the screw cutting engine equal distances for even revolutions. These distances are indicated by the graduations of a standard bar 40 inches in length, placed in the bed of the engine; the microscope by which the measurements are made being attached to the carriage of the engine. The screw of this cutting engine is three inches in diameter and is standard at a temperature of 62° Fah.; the maximum error of this screw does not exceed $\frac{1}{4000}$ inch in 6 feet.

Before being sent to Cambridge the screws of the apparatus we are describing were tested by placing on the frame a bar graduated to tenths of inches, and moving it half and whole revolutions under the microscope. The coincidences at half revolutions furnished a test of freedom from periodic errors of single revolutions, while the coincidences with lines one-fifth of an inch apart furnished a test of equality of pitch.

It will be seen from our view of the measuring machine under notice that the microscopes, o, f, p, are so situated that the observer can examine the photographic image and read both index wheels without moving from a sitting position. The total weight of the apparatus is about 900 pounds.

We are indebted to Engineering for the engraving and description of the apparatus.

## CIRCULATION OF STEAM FOR HEATING PURPOSES.*

THE natural circulation of steam in any system of piping is governed by natural laws of inertia, friction, and, to some extent, of capillary attraction. Steam entering any pipe traverses the tubular space like other bodies, at a rate dependent upon its superiority of pressure over the resistance encountered. It is subject during its progress, however, to a diminution of its volume, due to condensation.

The products of this condensation, being of a heavier nature than the elastic vapor, will continue their motion only to the degree to which speed is imparted to them by the travel of the steam. If perfectly free of all frictional contact, their speed would be a natural acceleration, but, owing to their adhesion to the skin of the tube, the effect of retardation is very marked.

At this point it may be instructive to point out that the common theory of the flow of condensed water in pipes is largely in error. It is usually assumed to be drifted along at the bottom of the pipe, while a visual study of the actual effect in a glass tube will show that it is propelled all around the interior surface, the effect of gravity being sensibly smaller than that due to capillary adhesion. The usual method of dripping pipes, especially large pipes, from their lowest level is, therefore, only partially correct; and a method more true to the conditions would be found in some arrangement of enlarging the pipe at each point of drainage, enabling water all around the interior circumference to find an exit from the drift of the steam.

Assuming the best possible condition of removal of condensation, it remains a scientific fact that the less resistance opposing the flow of the moisture, the easier will be its passage and the less the reduction of speed of the flowing steam. Common practice deals with initial pressures from 15 pounds downward and with resisting pressures from atmospheric pressure upward. It is now demonstrable that, by a system of partial vacuum, it is economically possible to relieve the steam of resistance to a still greater extent. A study of the figures of the flow of liquids in standard pipes will demonstrate that the advantage in ease of flow of steam is on the side of a low pressure system into a partial vacuum as against one pressure of steam into another.

The common forms of radiators, with their many points of merit and demerit as regards circulation of the heated air over their surfaces, may all be regarded from the point of view of enlargements of the pipe system. Common practice in any steam pipe enlargement would demand an efficient and automatic drainage or drip of the lower water-filled portion by some form of trap. The enlarged portion would further present an air pocket which it would be the effort of the engineer to relieve. It would not suffice to do one and leave the other undone. To relieve the air gases only would leave the drainage at the mercy of circumstances, but if the water drip were to be sufficiently efficient and to extend freely into a lower drainage system, the air gases, after once being preliminarily removed, would automatically be drawn off with the drainage. Air is heavier than saturated steam in the proportion of 1 to $\frac{5}{8}$ at atmospheric pressure. It is a mechanical operation which drives the excluded air into the upper portions or extreme ends of radiators and coils. It therefore follows that steam, being once fully admitted to the contents of an enlargement, the air or gases, afterward liberated by condensation, are best drawn off at the point of drainage.

On the other hand, any open system of drainage controlled at will by the operation of hand valves must necessarily be liable to derangement of operation by the least negligence of attendants. If the outlet valve, for instance, is at the disposition of the tenant of a room, it is unlikely to be at any time set so as to dispose of the products of condensation at the proper rate.

The primary requirements for effective steam heating systems are:

1. Absence of back pressure on motive engines where exhaust steam can be utilized.
2. Efficiency of drainage of supply pipe system preliminary to drainage of the radiating surface.
3. Continuous automatic drainage of condensation.
4. Effectiveness of circulation.
5. Control, or variability at will, of circulation.
6. Removal of air and gases from heat surfaces and from feed water.
7. Regulation of temperature in any part of heating surface.
8. Return of water from some moderate distance below the line of drip or drainage, if necessary.

It is unnecessary to state that there are claimants for success in dealing with one or other of these conditions, but that apparatus which does not demonstrate its capability of compliance with all, seeing that all of them are natural features to be encountered in any heat system and are due to natural causes, must by the heating engineer be considered incomplete.

The requirements of the above, it will be noticed, are not fulfilled by any system employing one pipe for supply and return, nor by any system removing only the air gases and not dealing with equal certainty

* From a paper by Reginald Pelham Bolton, read at the third annual convention of the American Society of Heating and Ventilating Engineers.—From Heating, Plumbing, Lighting.

with the water of condensation, nor by any arrangements establishing a partial suction, in a coil or radiator in such a way as to act in opposition to the free drainage of the condensation, nor by any apparatus requiring more than one hand valve for regulation by unskilled persons of a coil or radiator, nor by any system incapable of lifting the drainage from a point somewhat lower than that of outlet or of final disposition.

## THE TORPEDO BOAT TURBINIA.

THIS is an age of sensational performances in the steamship world, and nothing more startling has ever occurred than the wonderful runs which have recently been made by a little craft called the Turbinia, in which the motive power is supplied by a steam turbine of the Parsons type. In reply to our inquiries, Mr. Parsons writes us that previous to the experiments in steamship propulsion his turbine has had a very extended trial in various classes of work, and particularly in driving dynamos for electric light and other purposes. He informs us that there are at the present time over 30,000 horse power aggregate at work in London alone, the greatest part of this total being in engines and dynamos of 350 and 500 kilowatts capacity.

We give below, by Mr. Parsons' courtesy, a paper which he read at the recent meeting of the Institution of Civil Engineers, in London, together with sectional views of this phenomenal little vessel.

### "ON THE RELATIVE ADVANTAGES AND DISADVANTAGES OF ROTARY AND RECIPROCATING ENGINES AS APPLIED TO SHIP PROPULSION."

By the Hon. CHAS. A. PARSONS.

The advantages of a rotary motor for the purpose of marine propulsion are manifest as regards a direct application of the force of the steam to the shaft to be driven, and a consequent saving of bulk, weight, friction and wear. When such a motor is shown to be economical in steam consumption, and that the power delivered by the motor at a high speed of rotation can be economically transformed into thrust power by the screw propeller, and that the whole of the machinery is simple and easy to work, the position of the rotary motor becomes well established as a rival of the reciprocating engine, provided there are no drawbacks to detract from the advantages which it manifestly possesses. Up to the present no such drawbacks have shown themselves, or seem likely to do so.

The compound steam turbine consists of a series of steam turbines set one after the other on the same axis, so that each turbine takes steam from the preceding one and passes it on to the succeeding one. Each turbine of the set consists of a ring of fixed blades called guides fixed to the casing, and also of a ring of moving blades attached to the shaft. The steam from the steam pipe entering all round the shaft passes through the first set of guides, then through the first set of moving blades, then through the second set of guides, then through a second set of moving blades, and so on through the complete turbine motor. The blades are carefully shaped, as in water turbines, and the action of the steam in each turbine of the set is similar to that of water in the water turbine.

Steam is, however, an expansive fluid, and though its action in each individual turbine is approximately as if the fluid was inelastic, yet a small increment of volume takes place at each passage through the blades, and the expansion going on at something like geometric ratio at each of the numerous successive turbines soon assumes large proportions. Ratios of expansion of fifty up to one hundred or even two hundred fold are common in one single compound turbine of the condensing type; a notable feature in turbine practice being that high expansion ratios and very large volumes can be economically dealt with without necessarily increasing the size and weight of the engine to any large extent, or what is perhaps more important and gives the turbine a special advantage over ordinary engines is that practically no increase in frictional resistances is incurred by arranging for the extra expansion, and exceptional economy in steam is thereby realized. The high speed of revolution diminishes not only the weight of the engines themselves in proportion to a given horse power, but also of the shafting, propellers, and supports, as well as of the hull. The total weight of machinery in vessels of the torpedo boat or torpedo boat destroyer class on the turbine system will probably not exceed one-third that of ordinary engines of the same power. The consumption of steam on recent trials on the Turbinia has been shown not to exceed 14½ lb. per indicated horse power at full load, or considerably less than that of similar engines of the reciprocating class, so that the size and weight of the boilers, and also the amount of coal carried, can be considerably reduced, and consequently the total displacement of the vessel to be propelled will be largely reduced, so that with a given horse power much greater speeds may be attained; or, on the other hand, heavier cargoes may be carried with a given consumption of coal per knot. To these advantages must be added that the space occupied by the turbines is very much less than that occupied by ordinary engines, thus increasing the capacity of the vessel, and also that the turbine machinery being placed near the bottom of the vessel, the center of gravity is thereby lowered, and the stability of the vessel increased. Also, owing to their position—and even in the Turbinia with only 3 ft. draught—they lie almost wholly below the water line, a matter of considerable importance in war vessels. The almost total absence of vibration, owing to there being no reciprocating parts, admits of a diminution in the weight of the hull, and in fast vessels admits of a degree of comfort not hitherto attainable, and also in the case of warships enables guns and torpedoes to be worked with ease and accuracy. Another feature is that owing to the reduced size and weight of the shafts and propellers, this not only facilitates duplication and repair, and enables spare parts to be carried on board the vessel to an extent not hitherto practicable; but also, owing to the smaller diameter of the propellers, it admits of screw-propelled vessels being used for navigating shallower waters.

To summarize, the merits of the turbine system applied to marine propulsion appear to be: (1) Greatly increased speed, owing to diminution of weight and smaller steam consumption; (2) increased carrying power of vessel; (3) increased economy in coal consumption; (4) increased facilities for navigating shallow waters; (5) increased stability of vessel; (6) reduced weight of machinery; (7) reduced cost of attendance on machinery; (8) reduced size and weight of screw propellers and shafting; (9) absence of vibration; (10) lowered center of gravity of machinery, and reduced risk in time of war.

The first ship fitted with turbine engines has been the Turbinia. She is 100 ft. in length, 9 ft. beam, 3 ft. draught amidships, and 44½ tons displacement. She has three screw shafts, each directly driven by a compound steam turbine of the parallel flow type. The three turbines are in series, and the steam is expanded—at full power—from a pressure of 170 lb. absolute, at which it reaches the motor, to a pressure of 1 lb. absolute, at which it is condensed. The shafts are slightly inclined, and each carries three screws, making nine in all. The screws have a diameter of 18 in., and when running at full speed they make 2,200 revolutions per minute. Steam is supplied from a water tube boiler, and the draught is forced by a fan, mounted on a prolongation of the low pressure motor shaft, the advantage of this arrangement being that the draught is increased as the demand for steam increases, and also that the power to drive the fan is obtained directly from the main engines.

Up to the present the maximum mean speed attained has been 32¾ knots, as the mean of two consecutive runs on the measured mile. These runs were made after about four hours' steaming at other speeds, and the boat on the day of the trials had been fifteen days in the water. It is anticipated that on subsequent trials, after some alterations to the steam pipe, still higher mean speeds will be obtained. As it stands, however, the indicated horse power realized is 2,100, and the consumption of feed water per indicated horse power hour 14½ lb., and the speed the fastest of any vessel irrespective of size. The weight of the main engines is 3 tons 13 cwt. Total weight of machinery, including turbines and auxiliary engines, condenser and boiler, the propellers and shafts, the tanks and the water in boiler and hot well, 22 tons. Thus nearly 100 horse power is developed per ton of machinery, and nearly 50 horse power per ton of displacement of boat.

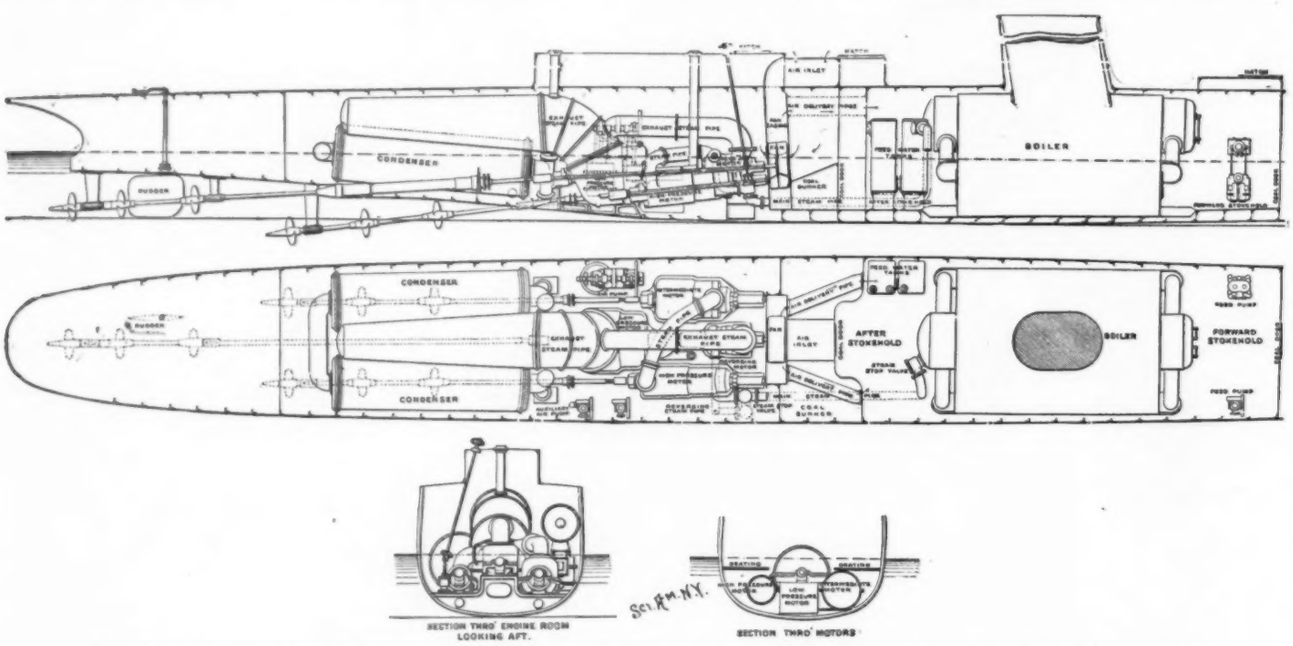
In the Turbinia the stresses on the boiler and machinery are, as far as possible, according to the Board of Trade rules, and the scantlings of the hull are heavy for a boat of her size and class. It is believed that when boats of 200 ft. in length and upward are fitted with compound turbine motors, speeds of 35 to 40 knots may be easily obtained in vessels of the destroyer class, and it is also believed that the turbine will—in a lesser degree—enable higher speeds to be realized in all classes of passenger vessels.

In the subsequent discussion, Prof. Ewing, who had superintended several of the trials of the boat, spoke in the highest terms of the practical value of this method of propulsion. Among other advantages, he mentioned the fact that the engines attained their full twenty-eight knot speed in twenty seconds after opening the throttle—the speed of the boat, of course, taking longer to develop. Other points indorsed by Prof. Ewing were: lightness, absence of vibration, and economy of space. It was difficult to determine closely the efficiency of the turbines, as no true indicated horse power could be taken; nevertheless, he found that the consumption of all the engines on board averaged about twenty-nine pounds of steam per effective horse power, and as several unknown factors, such as the efficiency of the screw, were included, he thought that the Parsons turbine would prove to be a little more efficient for marine propulsion than the reciprocating type of engine.

It was suggested by Mr. Froude that a better arrangement might be found for the propellers, and he thought that better results would be obtained if the engine were geared down and single propellers were used running at moderate speeds.

Sir William White, chief constructor of the British navy, touched on the really vital defect of the turbine for marine propulsion when he spoke, in the discussion, of the inability of the boat to go astern—a serious tactical drawback in naval warfare. It is necessary to add a second motor for this purpose, which must necessarily be idle during most of the time. In reply to this, Mr. Parsons said he was about to put in a second motor weighing about three-quarters of a ton, which would enable the boat to go astern at a twelve knot speed.

In the course of a paper on "Turbines applied to dynamos," read at the same meeting, the author gave the following description of the compound steam turbine, which will apply to the engines of the Turbinia: The compound steam turbine of the "parallel flow type" consists of a series of parallel flow turbines set one after the other on the same shaft, so that each turbine takes steam from the preceding one and delivers it to the next. The steam, entering by an inlet all around the shaft, passes through the successive turbines of gradually increasing area of passageway, and is expanded by small increments of volume at each turbine, till it arrives at the next series of turbines; these are of larger diameter, and consequently greater peripheral speed and capacity, and they allow of further gradual expansion. The steam then flows to the last series of turbines, where, the expansion being completed, it passes to the exhaust pipe. The rows of turbine blades are formed of hard brass, and accurately shaped; those keyed into the shaft project outwardly, and nearly touch the case; those keyed into the case project inwardly between the moving rows, and nearly touch the shaft. The turbines are so proportioned that the steam passes from one row to the next throughout the entire turbine with the most suitable velocity for economical working under the prescribed conditions. On the right are the dummy or rotating pistons to balance the end pressure of the steam.




SECTIONAL VIEWS OF THE TURBINIA, SHOWING ARRANGEMENT OF THE TURBINES AND THE NINE PROPELLERS.

## THE STRIKING OF A MEDAL AT THE PARIS MINT.

IN a few days the Paris mint is to strike a magnificent medal, due to M. Chaplain, the eminent engraver, and designed to commemorate the visit of the Emperor and Empress of Russia to France. The design and fine workmanship of this medal will undoubtedly be admired. It is well to admire, but how does one succeed in making such chefs d'œuvre? How is the operation performed at the mint?

The Russian sovereigns in their visit to the Conti quay desired to be initiated into this work, and their majesties were, therefore, allowed to be witnesses of the striking of some medals. We also have endeavored to see what the Czar and Empress witnessed at the mint, and M. A. Patey, engraver of coins, has been good enough to show us upon the spot the successive operations that at present permit of striking the remarkable medals that come from the mint.

The artist who purposes to execute a medal must first make several sketches. He obtains the details of these either from living models or by using manikins, which he dresses to suit his taste. After the composition has been decided upon, it is executed in bass relief. To this effect, certain artists use wax, and others modeling clay. After the model has become sufficiently advanced, it is moulded. The plaster cast obtained is touched up, moulded anew, then touched up again, and afterward handed over to the founder, who makes a casting of iron or bell metal. Use is sometimes made of copper obtained by electro metallurgy, and which is nickel plated in order to give it greater strength. This proof on a large scale is to serve for a reduction, which is made by means of a special lathe and the application of a pantograph, to the size desired and from a piece of well annealed steel. In this way is obtained the die. This primitive die, however, is merely a rough piece of work that the engraver must retouch very carefully in going over every line until he is satisfied with his work. The finished die is afterward tempered so as to give it great resistance, and this tempering requires certain special precautions. The die must not come into direct contact with the fire. It is placed face downward in an iron plate box or a fire clay pot, and is surrounded and completely covered with powdered charcoal. The whole is afterward raised to a temperature of from 700° to 800° in a furnace, according to the kind of steel used. Then the die is abruptly plunged into water. After this, the die thus tempered is set into an iron ring (A, Fig. 2), that permits it to resist crushing at the moment that it is submitted to the action of the coining press.

With this die in relief it is now a question of preparing the matrix properly so called. For this there is taken a piece of well annealed soft steel of a diameter greater than that of the die, and so thick that it has but slight elasticity. One of its extremities terminates in a point (B, Fig. 2). The die is now placed in the coining press, a general view of which is given in Fig. 1. The fly of this actuates a central screw which, in its descent, exerts a determinate pressure upon the object with which it comes into contact. The point of the piece of steel that is to be converted into a matrix is placed, exactly in the center, above the die under the screw of the press. The fly is then revolved in order to cause a pressure. The screw is made to descend gently at first, so as not to disturb the die, and then a second and third turn is given. The point of the piece of steel is crushed and takes a partial imprint of the die.

After the matrix is formed it is annealed, that is to say, raised to red heat under shelter from the air. It is afterward allowed to cool very slowly, and on the next day the operation is renewed. The arrangement of the die and matrix is now reversed, the die this time (D, Fig. 2) that allows it to enter the ring of the press, and is finally retouched with tools and finished with the utmost care. It is finally tempered and set into a ring just as the die was. In this way is obtained the face. The reverse is formed in the same manner.

It would be possible to obtain the matrix directly by engraving it in a block of steel, but should a breakage occur in the tempering or during the striking of the medal, the entire work would have to be done over again.

The obverse and reverse pieces (A and C, Fig. 1) having been prepared, the operation of striking may be begun. In order to strike medals it is necessary to use the coining ring, A, which is designed to receive the matrices and prevent the metal from overspreading and extending under pressure. This piece is of steel and iron

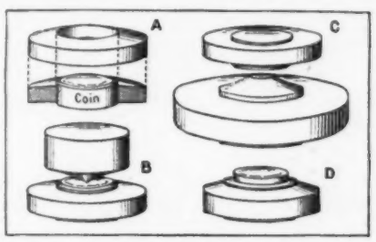



FIG. 2.—DETAILS OF DIES AND RINGS.

and is tempered. After it has been fixed, it is necessary, in order to strike the medal, to use a blank punched out of a sheet of rolled metal of the requisite thickness. One of the coins, usually the face one, is placed in the press and is embraced by the ring. Above this is placed the metal blank, and above this again the reverse coin. Two turns of the fly and all is finished. The reverse coin is first removed, and then the ring, which firmly holds the medal. This is the operation that is represented in Fig. 1. The blank is driven from the ring by a tool which is hollowed out beneath so as to touch only the edges, and by a single blow of a hammer. All is not yet finished, for the medal thus obtained is only in a rough state. In order to reach perfection, it is necessary to have recourse to several more turns of the fly—two or three for small modes, and from six to thirty for large ones. After each operation, the blanks must be submitted to annealing and cleaning. It is well also to file and turn the edges, so that the medal may enter the ring easily, and that the registering may be done with accuracy. It will be seen that the series of all these operations is complex and delicate. The striking of a medal requires artistic talent of a high order and also great skill on the part of the workmen.—La Nature.

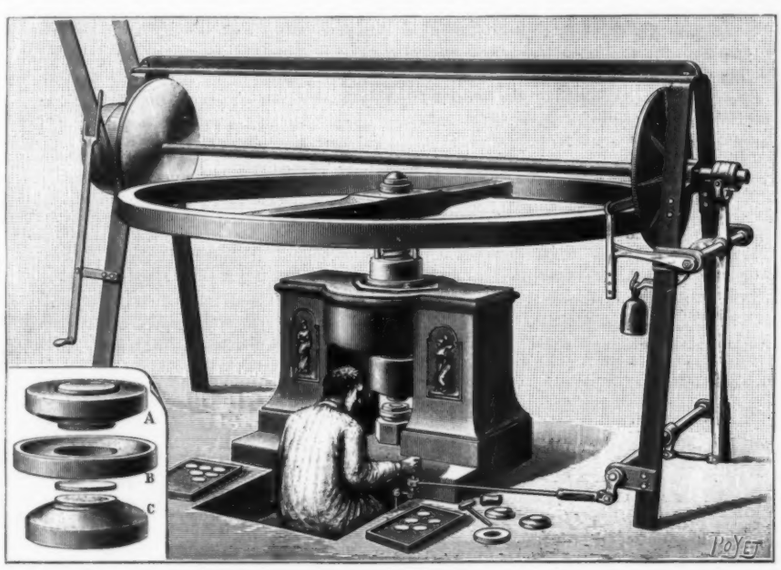



FIG. 1.—GENERAL VIEW OF A COINING PRESS SUCH AS IS USED AT THE PARIS MINT.

## FLUORESCING SALTS.

By THOMAS A. EDISON.

FURTHER experiments, beyond those already recorded by me in the Electrical Engineer, have been made with crystals sensitive to the X ray of Roentgen. The following are selected from a large number of chemicals made at my laboratory, all the chemicals in commerce having already been tested and reported: Borate of sodium and uranium; cyanide of copper and zinc; cyanide of copper and silver; cyanide of silver and calcium; cyanide of silver and tin; cyanide of silver and strontium; cyanide of silver and barium; cyanide of copper and lithium; phosphate of uranium being placed above (C, Fig. 2) and the matrix below in a strong ring, in order to prevent any danger of crushing. The registering is done with great care, so that the images shall not become double, and that the lines already traced shall agree exactly. The striking is continued until the necessary depressions and sharpness of the lines is obtained. The metal lends itself more or less readily to this operation, which the artist helps along with the graver and scauper. After this operation is finished, the piece is turned into a form and ammonium; phosphate of uranium and silver; nitrate of uranium and lead; cyanide of uranium and silver; nitrate of uranium and strontium; nitrate of uranium and potassium; benzoate of uranium and copper; benzoate of uranium and cadmium; dicalcium tungstoborate; dimanganese tungstoborate; cyanide of mercury and chromic chloride; cyanide of mercury and fluoride of calcium; cyanide of cadmium and silver; phosphate of uranium and calcium; phosphate of uranium and zinc; phosphate of uranium and sodium; phosphate of uranium and magnesium; phosphate of uranium and aluminum; phosphate of uranium and beryllium; phosphate of uranium and manganese; cuproso potassic cyanide; cyanide of iron and barium; cyanide of cerium and copper; cyanide of copper and molybdenum; cyanide of copper and barium; cyanide of copper and iron; cyanide of copper and zinc; cyanide of cerium and silver; cyanide of copper and cadmium; cyanide of copper and manganese; cyanide of cobalt and copper; nitrate of uranium and silver; nitrate of uranium and lithium; nitrate of uranium and barium; acetate of uranium and copper; acetate of uranium and silver.—Electrical Engineer.

## THE BEST METHOD OF SEWAGE DISPOSAL ON FARMS AND IN SMALL COMMUNITIES.

DR. B. C. BRETT has recently published in the Medical Age an interesting article in which he says:

Sewage is usually defined as refuse or waste matter suspended or dissolved in water and conveyed away by sewers. For the purpose of this paper the word "sewage" is designed to include all refuse matter which might be conveyed away by sewers if they existed, but which in the absence of them is disposed of in some other way. As any system of sewage disposal which is applicable to the farm may be equally so to individual houses in small communities, I shall simply describe what appears to me the best method for the farm.

It must be granted, I think, that under favorable conditions there is no way to dispose of sewage so good as by sewers. I believe that the introduction and successful management of house sewers, even by many small farmers of very moderate means, is entirely practicable. Although a great convenience, it is not indispensable that there should be a system of water supply in the house in order to secure the successful working of a house drain. In the first place every farmhouse should be situated upon a rise of ground above the stables and other outbuildings, in order to facilitate safe and rapid drainage, toward a stream of water if possible. Let it be supposed that a farmhouse so situated is occupied by a family possessed of some refinement and good taste, of a fund of general information, including some knowledge of hygiene, and that they have a desire to live decently, but have only limited means. They have discussed the dangers of the privy vault and realize that its existence is a constant menace to health and a relic of semicivilization quite intolerable. They have learned that a kitchen sink with its drain leading outside and ending in a sink hole or cesspool is even more dangerous than a privy vault. They have read that the refuse matter contained in the vault and cesspool, if deposited over a considerable area of ground surface, or under the surface, but within ten to twelve inches of it, and, therefore, within easy reach of oxygen and microbic action, soon becomes innocent and inoffensive, and that even its filthy water becomes as pure as a meadow brook. They find by inquiry that a siphon closet can be flushed by a pail of water, and that if they have a warm corner in the house where the temperature will not freeze the water seal in its trap, they can have a water closet even though they have no constant water supply. They learn that a kitchen sink will always have water enough to flush its trap and will therefore be easily cared for. They find that a four inch vitrified sewer pipe is not very expensive, and that if laid with cemented joints and no rough inside projections, and with a good true inclination, it will be a durable affair and likewise self-cleansing. They conclude that an iron sink with nonsiphoning trap, and a siphon water closet, with iron pipes to properly connect them with the vitrified sewer pipe outside the house, will supply all the actual needs of a comfortable home. They have decided that the sewer shall terminate some twenty rods below the house in several branches, each connecting with a few rods of tile drain laid with open joints four inches below the surface. They decide to underdrain the area where the sewer terminates in the tile drain, so that the surface may not be too moist for vegetation, and that the waste water which may find its way from the tile drains near the surface to the underdrains may run away to the brook below as sparkling, limpid and pure as the water in the brook above it. All of this and much more has been learned by consulting some work, perhaps the little book by George E. Waring, Jr., on "How to Drain a House." They find that the expense of the sewer and the two inside fixtures mentioned is within their means; they build it, expecting in a few years to be able to add a water tank in the attic, to be supplied daily from the well by a hand force pump in order to lighten the labor of flushing the closet by hand at each time of using. They know that closet and sink and sewer must have daily care that they may not become dangerous to the health of the household, but they are willing to undertake this care for the comfort which it insures.

Of course, there are many farmers who are able to have artesian wells and machinery to pump water to a supply tank in the upper story of the house, and such can have all the conveniences that their urban brethren enjoy. For these the best method of sewage disposal is by sewers terminating in surface or subsurface tile drains, its purification being accomplished by bacterial action in the soil. But for by far the larger class of farmers, those of quite limited means and unfavorable location, the question of sewage disposal in the best way, from a sanitary standpoint, is not so simple. Among the most ignorant of this class we too often find the house situated in a hollow, with the privy vault and barn above it, and the well which supplies water for both house and barn located between the buildings near the edge of the barn yard. This arrangement is sure to bring disaster to the occupants of both house and barn; and to him who could be content to live in such surroundings, death must come before education could penetrate his dense ignorance of sanitary laws. In the example of his superiors there is hope for his children, if fortunately they survive. But setting aside the extremes of farm life, we know that upon the premises of those who suppose that they live decently, the privy vault and the kitchen sink with its wooden drain and slop hole are almost invariably found. Now as these are the abominably putrid receptacles of the sewage of the house, how shall we abolish them and create the best possible substitute?

Before attempting a solution of this question, I will state that sewage of any kind is inoffensive until at

commences to decompose; hence the necessity of early removal before decomposition commences, or of the addition of material suitable for the absorption of gases during incipient fermentation before removal is possible. The waste wash water of a house can be disposed of by pouring it broadcast on a porous ground, where it rapidly dries or is absorbed; a week's time suffices to purify the ground by bacterial growth. It is better, however, to pour it over a large pile of broken stones composed of pieces of from one to two inches in diameter; the large surface area of the broken stones causes the thin film of dirty water which covers it to become freely exposed to the air, and its oxygen favors rapid bacterial growth and decomposition of the soapy water, preventing putrefaction; hence no unpleasant smell or appearance as occurs when such water stands in a hole in the ground. This stone pile could be so saturated once or twice a week, not oftener, for fifty years and never become offensive, provided the ground beneath should be so porous as not to allow a pool of water to remain from day to day beneath the stones. The water should not be too near the boiling point when poured out, lest the microbic action be retarded by too high a degree of heat.

In relation to the disposition of sink slops: The sink should be connected with a nonsiphoning trap, and this by a lead or iron pipe to a four inch vitrified drain-pipe well laid with cemented joints well smoothed inside, leading by a true gradient to a system of branching tile drains; the latter should be laid with open joints nearly on a level, and in parallel rows eight feet apart and four inches beneath the surface. This area, which is for the absorption and putrefaction of the sewage, should be situated several rods from the house. The soil in which the drains are laid should be porous, or if of clay should be underdrained four feet deep and eight feet apart, and between the upper rows of tiles.

The trap under the sink and pipe connecting it to the cemented drain outside of the house should have ample protection from frost; the entrance to the trap at the bottom of the sink should be securely grated to exclude anything which would clog the trap. A house drain to which only the kitchen sink is attached need not necessarily be a four inch pipe; a two inch one, in my belief, would be ample, and perhaps better, than the four inch one, but it would require far greater care in laying to a true gradient, and in having no projections of cement on its inner surface. This drain would need no trap outside of the house and no fresh air inlet; the nonsiphoning trap being the only fixture connected with it, I believe there would be no need for a vent pipe extending through the roof of the building. The sink trap, however, would need the daily and thoughtful care of the housekeeper, as does any fixture and drain in any house, whether in country or city. Rain water from the roof should be excluded from this drain, because the flooding of the tile drains at its termination would interfere with their drying out at intervals and would therefore retard bacterial action.

I now come to the substitute for the privy vault. For this I prefer the "dry earth closet." If this closet is to be a success, there must first of all be a plentiful supply of dry earth (or earth which will become dry) stored in the summer for the whole year. Loam is the best material, sand being for this purpose worthless. It should be stored in a dry place raised from the ground, and convenient to the privy. This storage must be as much a business in its season as the storing of ice in its season. The vault, if there is one, should be cleaned and filled with earth. The privy should open from the woodshed, or from some other outhouse, so as to be sheltered from wind and storm. The receptacle for excreta should be a strongly constructed box six feet long (or of length to conform to width of building), three and one-half feet wide at top and three feet at bottom; made of thick oak planks, sides, ends and bottom, with watertight joints, spiked together, iron bound, and its bottom fastened permanently to two runners on which it should rest when in place under the privy seat. It would be well to have two of these boxes so that they might at each interval be exchanged. There should be no excavation of the ground beneath the privy. The box setting on level ground, supported on its runners, when nearly filled could be easily drawn away by chains attached to staples on the ends of the runners, and its contents buried in the soil or in the compost heap. The privy could well occupy one corner of the shed at some farmhouses where there is shed room to spare; that it should be made as warm and comfortable as possible goes without saying; in one corner of it should be stored in a box several bushels of the dry earth before mentioned, and a shovel always there capable of taking up two quarts of this earth for deposit upon the excreta immediately after each evacuation. Enough earth should be used to prevent all odor and absorb the moisture, and if the earth is dry, less is required for this purpose than one would suppose.

Such a closet has been made to deposit the earth automatically, and it can be made so inoffensive as to be placed in any room as a common article of furniture. The dry earth closet is no experiment; it has stood a fair trial in this and other countries, and when well and carefully managed has been found to be a great advance over the vault system. In conclusion I will add:

That the best system of sewage disposal easily becomes the worst by neglect of details in properly carrying out the plan proposed.

That there are few subjects in which there is so little interest taken or so much ignorance displayed by the average farmer or inhabitant of a small community as in that of the proper disposal of sewage.

That general improvement in the methods of sewage disposal can be realized only after general diffusion of knowledge on the subject has been accomplished.

That the diffusion of this as well as all other sanitary knowledge among this class of people must be accomplished mainly through the efforts of the medical profession.

Green Bay, Wis.

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According to the Regierungsbote the total population of Russia, taken by census in January of present year, was 129,211,833, against 108,819,332 in 1885; the extent of the empire is 18,990,735 square versts. Of the large towns, St. Petersburg has 1,267,023; Moscow, 988,610; Warsaw, 614,752; Odessa, 404,651; Lodz, 314,780; Riga, 282,943; and Kieve, 248,750 inhabitants.


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